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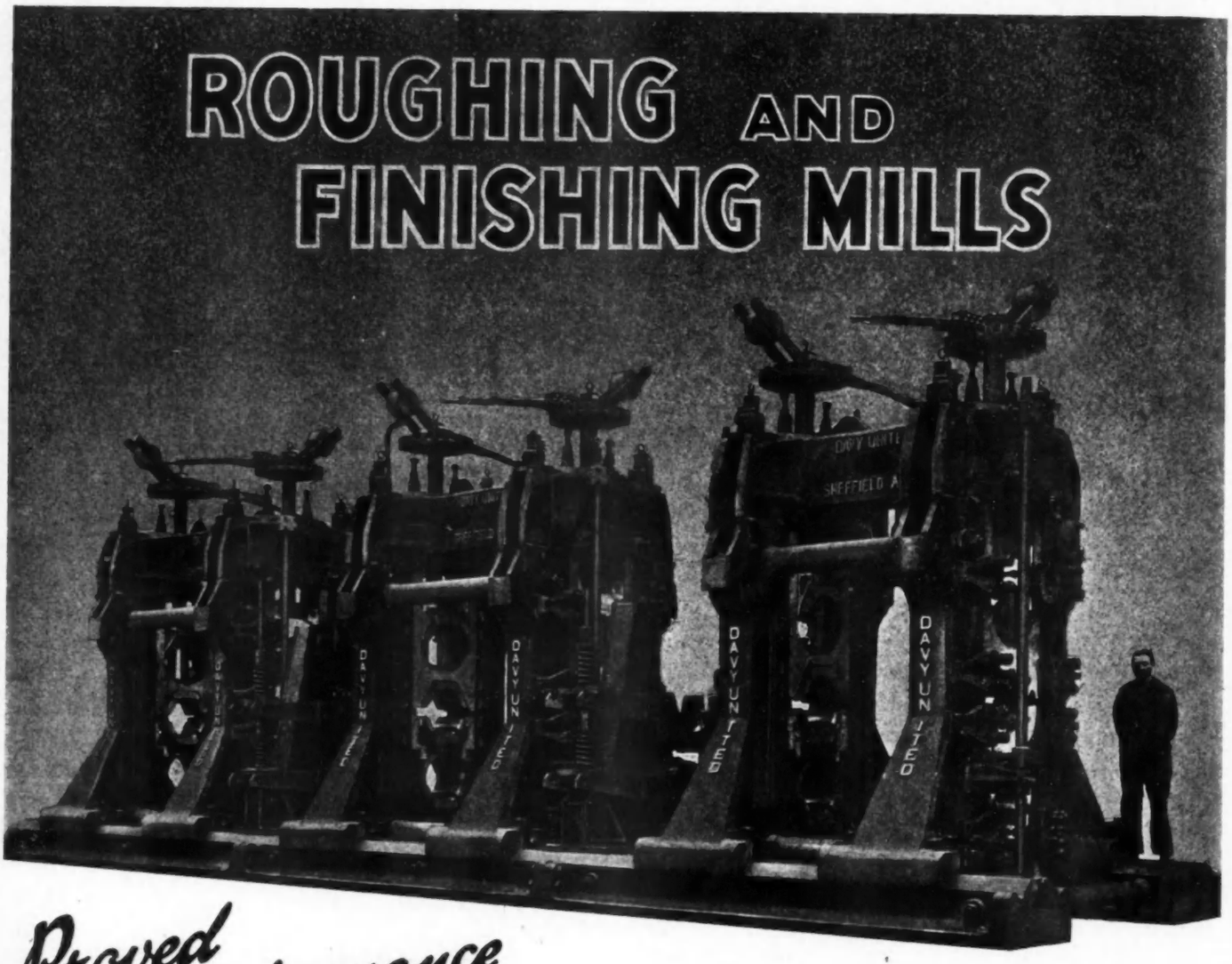


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# DAM CONSTRUCTION IN THE TENNESSEE VALLEY.

*(Continued from page 83.)*

AT the site of the Wheeler Dam, the Tennessee River is confined between cliffs, the rock formation of which extends entirely across the bed of the river and does not carry any overburden. The structure consists of a series of nearly horizontal layers of blue limestone and a flinty silicious rock, the layers of the latter being much thicker than the former. Most of the few vertical joints are confined to one stratum. There are, however, occasional cleavages extending down through several layers of rock, and a number of small cavernous fissures were uncovered. These were of no consequence, except two in the foundation of the draft tubes. Hollows or fissures of this kind were filled with concrete or grout without difficulty, and an entirely satisfactory foundation was obtained. In view of the nature of the rock, great care was exercised in selecting the method of excavation to be employed. Except for the heavy cut required to obtain the necessary depth for the substructure of the power plant, most of the excavation was comparatively shallow. In general, it was only necessary to remove sufficient of the upper weathered strata to get down to solid rock. Apart from the power plant area, the depth of excavation varied from 10 ft. to 15 ft., and the total quantity of rock removed was about 600,000 cub. yd.

Excavation for the power-plant substructure extended down to a depth varying from 50 ft. to 57 ft. below the river bed. As it was considered that blasting might disturb and crack the rock formation in the neighbourhood of the deep excavation which was necessary, an interesting method of line-drilling was employed. In this way a pit with vertical walls, and of the exact shape necessary for the substructure, was obtained. Blasting was used towards the centre of the excavation, but no blast holes were put down within 30 ft. of the line-drilled faces. For the line-drilling, twelve portable rock drills were employed. These were mounted on temporary tracks, so that they could be moved sideways and could form a line of holes pitched at 4½-in. centres. An early stage of the work, showing five drills operating in a line, is illustrated in Fig. 42, on Plate X. The clean shear faces which were produced by this method of working are well shown by Fig. 43, on the same Plate. This illustrates a later stage of the work, when one of the lower lifts was being drilled and the excavated material from the upper lifts had been removed.

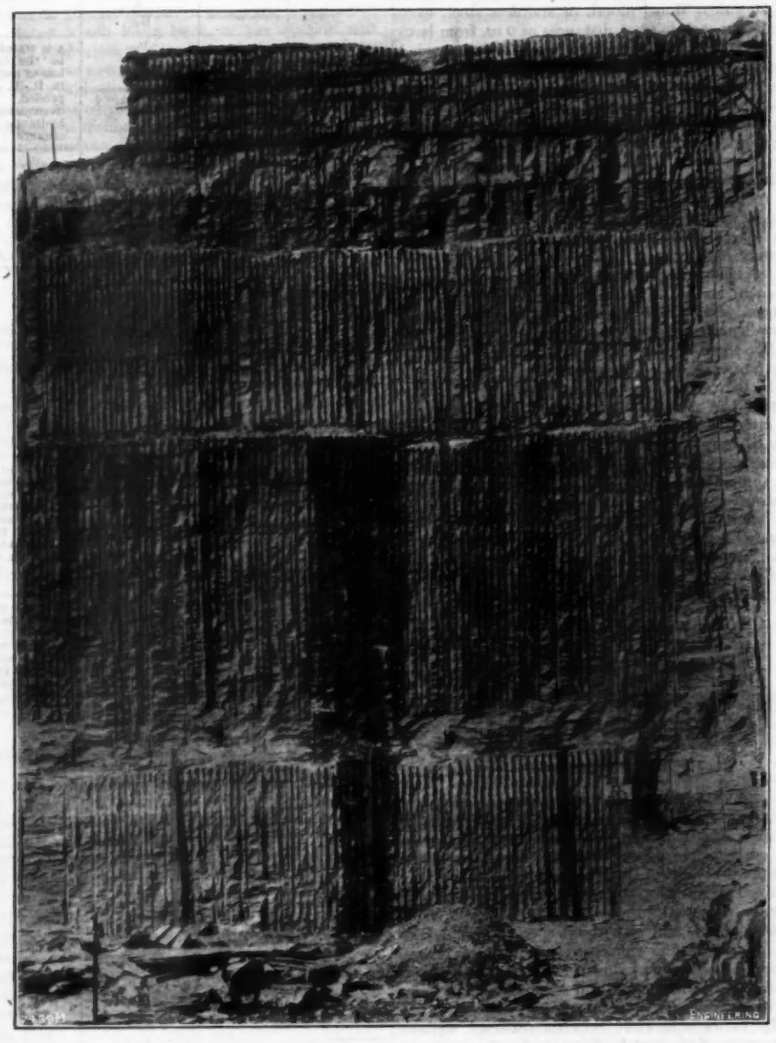


FIG. 46. FACE OF ROCK AFTER COMPLETION OF LINE-DRILLING.

The drills were fitted with 2⅞-in. diameter bits on 18-ft. steels, so that it was possible to form holes 15 ft. deep. They were operated in gangs of three to five, and as it was clearly not possible for the drill centres to be placed 4½ in. apart, they were spaced so that as the gang as a whole was moved sideways, the second drill produced a hole lying alongside that made by the first. Another move then brought the third drill to a position next to that which had been occupied by the second, and so on. The work was carried out in cuts of about 15 ft., so that, in general, four lifts were required to complete the excavation. The early stage of the work, illustrated in Fig. 42, shows the state of affairs when one lift had been taken out. The rock face after four lifts had been completed is shown in Fig. 46, on this page. It will be clear that after one lift had been finished it was not practicable to set the drills to produce a vertical face directly below the one which had already been formed. It was necessary to arrange some clearance for the drill mechanism, otherwise it would have fouled the vertical face which had already been formed. The matter was dealt with by arranging each row of holes, apart from the first, 10 in. out from the rock face, the drills being set at such an inclination that the bottom of the holes came vertically below the holes of the first lift. As a result, the finished rock face was formed with a series of narrow steps, the main line, however, from top to bottom, being vertical. The narrow steps can be seen in Figs. 43 and 46.

The formation of the pit required a certain amount of contour work in the neighbourhood of the turbine seatings. This will be seen from Fig. 44, on Plate X, which shows the completed excavation. This phase of the work did not present any difficulty, a set of three drills operating on a steel track carried by portable timber runways being employed. The nature of the formation is such that, with reasonable care, it was possible to break away the rock from the inside of the excavation without shattering the vertical faces. A certain amount of small-scale blasting had to be employed to break up some of the larger pieces which were detached, but, as already mentioned, no heavy blasting was carried out within 30 ft. of the line-drilled faces. The material which was removed from the pit was used partly in the construction of the cofferdams and partly for making up a flat area on the south bank for the control room and workshops, which were described in our previous article. The remainder was removed by water and tipped into the river in positions where it did not interfere with navigation.

The method of line-drilling proved so successful that its use was finally extended to other sections of the foundation work; in some cases it was employed on cuts as shallow as 6 ft. In addition to the advantage of the procedure in leaving the native rock unbroken, it was possible to work so closely to the required foundation dimensions that the saving in concrete was found to offset the cost of the drilling.

The excavation for the power plant was carried out in rock of very uniform quality, but for the rest of the dam it was considered desirable to carry out grouting in order to ensure a watertight foundation. Accordingly, lines of holes, one 1 ft. upstream and the other 19 ft. downstream, from the axis of the dam, were made by the portable drills. These holes, which were 2½ in. in diameter and were carried down to a depth of 20 ft., were spaced 20 ft. apart in the rows. As no mud seams had been found, it was not considered necessary to wash them out. Neat cement grout was forced into the holes from a portable plant, caps on adjacent holes being removed, when any hole was being treated, in order to permit the grout to flow through any seam which might exist between the holes. In very few cases, however, did grout pass from one hole to another. A pressure of 20 lb. per square inch was first used, and gradually raised to 50 lb. per square inch. Most holes did not take more than enough grout to fill them. High-pressure grouting was also carried out after the first 10 ft. of foundation concrete had been laid. To enable this to be done, the necessary holes were drilled beforehand and pipes extending above the level of the future concrete layer were fixed in them. After the placing of the concrete, grout was forced into the pipes under a pressure of 100 lb. per square inch. None of the holes so treated showed any loss of grout.

The dam was built inside five cofferdams, of which the first covered the power-plant site. This was

built of timber with an earth filling, and was 1,425 ft. long; it can be seen in Fig. 44. The second cofferdam, which was 1,238 ft. long and was situated immediately alongside the first, can also be seen in the same illustration. It was built of rock-fill from the power-plant excavation, with a clay bank on the outside. The remaining cofferdams, which carried the work across to the other bank of the river, were, however, of earth-filled timber construction, similar to the first. Their lengths were 1,238 ft., 1,147 ft., and 1,004 ft. The work progressed from the south bank, the third cofferdam, for instance, being unwatered when the excavation in the second was nearly finished. The entire spillway section, which lay within the second, third and part of the fourth cofferdams, was built in alternate sections, 15 ft. and 30 ft. long. This is illustrated in Fig. 45, on Plate X, the 15-ft. sections being those which are being constructed to full height. The intermediate, 30-ft. sections, were at first carried only to a few feet above the level of the water below the dam. This level normally remained practically constant as the area immediately below the dam was formed by the upper end of the pond created by the Wilson Dam, 15½ miles downstream. The low, 30 ft., sections were provided, however, as there was always the possibility of flood conditions, which might raise the level of the river above the dam by some 4 ft. or 5 ft. Under such conditions, the excess water was free to escape through the low 30-ft. sections instead of building-up behind the dam works. The 15-ft. sections were carried to full height and the upper roadway was constructed in order to provide means of access to the work in the later cofferdams. The reinforcement for some of the concrete piers which carry the roadway can be seen in Fig. 45. The non-overflow section, at the north end of the dam, which lay inside the fifth, and part of the fourth, cofferdams, was constructed to the full height and without any breaks.

The 30-ft. sections in the spillway were finally closed between April and November, 1936. This is a time of the year at which floods are rare and the work could be carried on without interruption. Provision for the discharge of any possible excess water coming down the river was furnished, however, by the eight power-plant intakes which, by that time, had been completed. The placing of the concrete for closing these 30-ft. sections, and, in fact, the greater part of the concrete work of the dam, was carried out by plants mounted on barges. The great length of the dam made operation from an overhead cableway impracticable, and consequently these floating plants had to be made use of. This particular aspect of the building of the Wheeler Dam has already been dealt with in these columns,* but a brief description of it may be given here in order to make this article more complete.

Navigable water was available, for the full length, on the downstream side of the dam, a constant level being maintained by the fact that the Wheeler Dam is situated at the top end of the Wilson Dam pool as already explained. Four floating plants were used, each equipped with a 2-cub. yd. concrete mixer. The plants were moored alongside the cofferdams and aggregate and cement were delivered to them by barge. The concrete from the mixers was dealt with in 2-cub. yd. tipping buckets which were handled by gantry cranes inside the cofferdams. The sand and gravel were obtained from points some 40 miles down the river, being excavated from the river bed. A dredger with a capacity of 200 tons per hour was employed. This was fitted with washing plant and screens and delivered sand and three sizes of aggregate to the barges which fed the concrete plants. The maintenance of continuous supplies, without interruption, required careful arrangements. It was desirable that the material should be delivered directly from the dredger to the dam site, as arrangements for any considerable storage *en route* would have been costly. As, however, the demand on the works naturally varied, some holding of material in stock was necessary from time to time, and this worked out at about 10 per cent. of the total. More than 60 barges and two tugs were kept in operation and no delays occurred in the concreting work due to waiting for aggregate, although the barges had to pass through three locks, one of which would only accommodate two barges at a time.

As will be evident from Fig. 45, a very large amount of shuttering was required in connection with the placing of the concrete. On the spillway structure and the non-overflow section it was possible to develop standard forms which could be used many times, but in the power-plant section nearly all the forms were special. This was not a very important consideration, as timber is cheap in the part of the country in which the dam is situated. The forms were designed so that the concrete was laid in lifts of 5 ft. The seals provided at the vertical contraction joints are of interest. Strips of No. 20 gauge Monel metal, or stainless steel, were inserted in each joint at distances of 9 in. from both the upstream and downstream faces. They extended from the rock foundation to the top of the dam and were coated with a layer of asphalt emulsion $\frac{1}{16}$ in. thick. The emulsion was allowed to set before the concrete was placed. In addition to these metal strips, an 8-in. diameter asphalt seal was provided in each vertical joint at a point 3 ft. from the upstream face. These joints also extended from the rock foundation to the top of the dam. The form for each seal was set as each 5 ft. lift of concrete was placed, the form being removed when the concrete had set, and the recess formed filled with hot asphalt. Two ½-in. steam pipes were placed in each recess. These were connected at the bottom, and as the lifts of concrete were placed extra lengths of pipe were connected, so that, finally, there was a double pipe running the full length of each seal. On completion of the concrete work, live steam was passed through the pipes, melting the asphalt and ensuring that it filled all the interstices of the joints.

As already mentioned, with the exception of the navigation lock, the Wheeler Dam was designed by the United States Bureau of Reclamation and was constructed by the Tennessee Valley Authority. The engineers in control were the same as those already mentioned in connection with the Norris Dam, except that Mr. Wilfred M. Hall acted as construction engineer and Mr. George P. Jessop as construction superintendent.

*(To be continued.)*

* See ENGINEERING, vol. 141, page 6 (1936).

# THE EFFICIENCIES OF THE CENTRIFUGAL PUMP.

By J. JENNINGS.

A PERUSAL of the English technical literature concerned reveals considerable differences in the meaning and names of the various efficiencies of the centrifugal pump. The accompanying table contains a résumé of the information that the writer obtained from the volumes in one library, and roughly represents that which is available to a student of the subject without special search. For instance, hydraulic efficiency is defined in several different ways, mechanical efficiency may have three different meanings, and manometric efficiency is not at all clear. Even the overall efficiency of the pump varies somewhat between different writers. Since some of the text-books on hydraulics have run to many editions, it may be expected that new editions are now being contemplated or that new books on the subject are being written. It is to be hoped that in these cases a more uniform and logical treatment will be put forward. The writer proposes to discuss briefly the various losses and efficiencies and their names in the hope of stimulating interest in the matter.

It is now the usual practice* to isolate the pump from its pipe system and assume that the useful head produced is the increase of total head from the suction to the delivery flange. Frictional losses in pipes and the delivery kinetic head are not normally debited to the pump. The overall efficiency is thus given by $\eta = \frac{w\,q\,h}{550\,P}$. If instead of $h$ the difference of static head between the suction and discharge reservoirs be inserted, the efficiency so found, termed static efficiency in one book, is really a partial plant efficiency, and this, when multiplied by the efficiency of the driving unit, gives that of the complete pumping plant. As such, it may be valuable.

* See B.S.S. No. 599-1939. Pump Tests.

*Table of Centrifugal Pump Efficiencies.*

| Reference. | Name for Efficiency. | Meaning. | Remarks. |
|---|---|---|---|
| *Hydraulics*, by F. C. Lea. | Gross | $\frac{P_W}{P}$ | |
| *Hydraulics*, by E. H. Lewitt. | Actual | $\frac{w\,q\,h_a}{550\,P}$ | |
| | Hydraulic | $\frac{P_W}{P - P_B}$ | |
| | Manometric | $\frac{h}{H_\infty}$ | |
| *Hydraulics and its Applications*, by A. H. Gibson. | Actual working | $\frac{P_W}{P}$ | $L_h$ is stated to be the total loss of energy in ft.-lb. expended in overcoming hydraulic resistance. |
| | Hydraulic | $\frac{h}{H_\infty + L_h/w\,q}$ | |
| | Manometric | $\frac{h}{H_\infty}$ | |
| *Applied Hydraulics*, by H. Addison. | Gross or mechanical | $\frac{P_W}{P}$ | |
| | Static | $\frac{w\,q\,h_a}{550\,P}$ | |
| | Manometric or hydraulic | $\frac{h}{H_\infty}$ | |
| *Centrifugal Pumps*, by J. W. Cameron. | Total overall | $\frac{w\,q\,h_a}{550\,P}$ | |
| | Hydraulic | $\frac{h_a}{H_\infty}$ | |
| *Centrifugal Pumps*, by G. Higgins. | Overall | $\frac{P_W}{P}$ | |
| | Hydraulic | $\frac{P_W}{P - P_B - P_D}$ | |
| | Head effectiveness | $\frac{h}{H_\infty}$ | |
| *A Practical Treatise on Single-Stage and Multi-Stage Pumps*, by R. Defeld. | Mechanical | $\frac{P_W}{P}$ | * Stated to be the designed lift, which may perhaps be presumed to mean that estimated from the velocity triangles. |
| | Hydraulic | $\frac{h}{H_\infty}$* | |
| *Mark's Mechanical Engineers' Handbook.* | Hydraulic | $\frac{h_a}{H_\infty}$* | * Notes that the angle to be used in the calculations is frequently different from the impeller exit angle. |
| *General Engineering Handbook* (McGraw-Hill). Chapter by R. L. Daugherty. | Total | $\frac{P_W}{P}$ | |
| | Mechanical | $\frac{(P - P_B)}{P}$ | |
| | Hydraulic | $\frac{P_W}{(P - P_B)}$ | |
| | Volumetric | $\frac{q}{q + q_L}$ | |
| *Proc. I. Mech. E.*, 1932, p. 637. Centrifugal Pump Characteristics, etc., Sherwell and Pennington. | Gross | $\frac{P_W}{P}$ | |
| | Mechanical | $\frac{(P - P_B - P_D)}{P}$ | |
| | Volumetric | $\frac{q}{q + q_L}$ | |
| | Hydraulic | $\frac{P_W}{(P - P_B - P_D - P_L)} = \frac{P_W}{P_W + P_F}$ | |

SYMBOLS.

| | |
|---|---|
| Horse-power delivered to pump shaft | $P$ |
| Horse-power delivered in water at delivery flange | $P_W = \frac{w\,q\,h}{550}$ |
| Horse-power expended in bearing and gland friction | $P_B$ |
| Horse-power expended in disc friction | $P_D$ |
| Horse-power expended in friction of flow | $P_F$ |
| Horse-power expended in leakage water | $P_L$ |
| Density of liquid | $w$ |
| Quantity of water delivered | $q$ |
| Quantity of leakage or short circuit water | $q_L$ |
| Total head increase between suction and delivery flanges | $h$ |
| Static head increase between suction and delivery reservoirs | $h_a$ |
| Calculated head due to pump based on an infinite number of blades | $H_\infty$ |
| Calculated head due to pump based on $z$ blades | $H_z$ or $H$ |

There are two main ways of classifying the losses in a centrifugal pump. The one used by the earlier writers was to divide them into two kinds:—(*a*) those due to mechanical friction; and (*b*) all those of hydraulic origin. The mechanical friction losses

included only those at the bearings and glands, and the hydraulic losses included all others. With this classification, which could be called classification A,

$$\text{mechanical efficiency } \eta_{mA} = \frac{(P - P_B)}{P},$$

$$\text{hydraulic efficiency } \eta_{hA} = \frac{P_W}{(P - P_B)},$$

$$\text{and overall or gross efficiency } \eta = \eta_{mA}\,\eta_{hA}.$$

A second classification, exemplified by Sherwell and Pennington's paper, is to divide the losses somewhat differently into three kinds :—(*a*) those involving a reduction of power delivered to the water ; (*b*) the loss due to the dissipation of the power supplied to the water which leaks back to the suction side through clearances and sealing glands ; and (*c*) the flow losses between the suction and delivery flanges. The losses (*a*) include bearing and disc friction, and, therefore, the corresponding efficiency, which is also known as the mechanical efficiency, is different from that in classification A. The hydraulic efficiency in this system only covers the losses involved in the production of the increase of head. Calling this system classification B :—

$$\text{mechanical efficiency } \eta_{mB} = \frac{P - P_B - P_D}{P},$$

$$\text{volumetric efficiency } \eta_v = \frac{q}{q + q_L},$$

$$\text{and hydraulic efficiency } \eta_{hB} = \frac{P_w}{P_w + P_f}.$$

The power $P - P_B - P_D$ supplied to the flow rate $q + q_L$, would, if there were no loss of head, increase the head by H, whereas actually it raises the head of a flow rate $q$ by $h$.

Thus

$$P - P_B - P_D = \frac{w\,(q + q_L)\,H}{550}$$

and

$$P_W = \frac{w\,q\,h}{550}.$$

Therefore,

$$\frac{P_W}{P - P_B - P_D} = \frac{q}{q + q_L}\,\frac{h}{H}$$

or

$$\frac{\eta}{\eta_{mB}} = \eta_v\,\frac{h}{H}$$

and

$$\eta = \eta_v\,\eta_{mB}\,\eta_{hB}.$$

Therefore, $\eta_{hB}$ can be expressed by the ratio $\frac{h}{H}$. The two classifications appear to be quite logical, but a source of confusion lies in the resulting ambiguity in the terms "mechanical" and "hydraulic" efficiency. There is no doubt that the disc and leakage losses are hydraulic in character, and therefore the fault in nomenclature arises in the latter classification. Since the quantity $\eta_{mB}$ is the efficiency involved in the transfer of the mechanical power of the shaft to the water, a more descriptive name would be "mechanical transfer efficiency," and since only flow losses are involved in $\eta_{hB}$, this could be called the "hydraulic flow efficiency."

In many books the term manometric efficiency has been used to denote the ratio of the actual increase of head to that expected, on the assumption that all the water is perfectly directioned by the vanes. This, however, is not an efficiency in the sense that its value is completely controlled by energy losses. The head $H_\infty$ is only attainable, even with a frictionless fluid, with an infinite number of infinitely thin vanes. With a finite number of blades, $z$, the maximum head possible, assuming the same bearing, disc, and leakage losses, is $H_z$, which is the same quantity as was denoted by H above. The ratio of $h$ to H could be called the manometric efficiency, but it is exactly the same as the hydraulic flow efficiency $\eta_{hB}$. There is confusion in some of the text-books between the quantity $\frac{h}{H_\infty}$ and $\eta_{hA}$. If the quantity $\frac{h}{H_\infty}$ is to be used as a design factor, it would be preferable not to use the word efficiency in connection with it. The term used by Higgins "head effectiveness" appears to be a good one.

## RADIATION FROM SOLIDS UNDER FLAME IMPACT.

GAS lighting depends upon the emission of radiation in the visible part of the spectrum from the products of combustion of gas. In the flat-flame burners, which made use of a non-aerated flame, the solid particles of carbon served as radiant emitters, but the temperature obtained was relatively low ; the overall radiation in these flames is of the order of 10 per cent. to 20 per cent., but the visible radiation from them is only about 0·04 per cent. Since the products of combustion of an aerated gas flame are essentially poor radiators, it is customary, for the production of radiant emission, whether in the infra-red or visible region of the spectrum, to utilise as the radiant material a heated solid body having suitable physical properties. The radiation from solid radiators used in gas appliances is purely thermal in character, according to the work of many previous investigators. For this reason, the efficiency of light production from gas is unlikely to be increased by the use of radiant material in thermal equilibrium with the hot products of the flame ; and there is no likelihood of any such efficiencies being obtained from gas, used under these conditions, as those obtained from the modern electric-discharge lamps, the efficiency of which now approximates to some ten times that of the ordinary gas-filled tungsten lamp. This very high efficiency has been obtained by making use of the phenomenon of luminescence, in one form or another. It has been suggested, therefore, that luminescence might be applied to light production from gas, for certain investigations have suggested that some substances, when in contact with a flame, emit radiation in excess of that given in accordance with the laws of thermal radiation.

The intensity of radiation $R_\lambda$ of a given wavelength $\lambda$, emitted by a body at a temperature T deg. K is given by :—

$$R_\lambda = E_\lambda - f(T) \quad . \quad . \quad . \quad (1)$$

where $E_\lambda$ is the emissivity of the body at the wavelength $\lambda$. The emissivity is equal to the absorptivity, $A_\lambda$, at the same wavelength, and neither can be greater than unity. In black-body conditions, where the emissivity is unity

$$f(T) = K_\lambda\left(\frac{-C_2}{e^{\lambda T} - 1}\right) \quad . \quad . \quad (2)$$

where $K_\lambda$ and $C_2$ are constants. Hence, the value of $f(T)$ for a "black body" may be determined at any particular temperature, and, if the absorptivity of any other body for a particular wavelength be measured at the given temperature, $R_\lambda$ may be determined similarly by multiplying by this absorptivity. Under certain conditions, as when taking part in chemical reactions, substances may emit considerably more radiation than is given by this law, the excess being known as luminescence. In plain black-body radiation, the energy emitted between the wavelengths to which the eye is sensitive, *i.e.*, from 3,600 Å to 7,500 Å, is only about 0·01 per cent. of the total radiant energy for a body at 1,000 deg. K., 0·08 per cent. at 1,500 deg. K., 0·3 per cent. at 2,000 deg. K., 0·7 per cent. at 2,500 deg. K., and 1·2 per cent. at 3,000 deg. K. ; and this represents a primary theoretical limitation to the use of any "thermal" emitter as a source of visible light. With electrical heating, the temperature of the emitter is limited by the physical properties of the material available. Using gas as a fuel, the upper limit is set by the temperature of the flame, though, under practicable conditions, the radiator can never attain the temperature of the gas flame. The higher the radiating power of the solid in contact with the flame, the greater will be the divergence between its temperature and that of the flame. Many "selective" radiators exist, in which the energy distribution over the spectrum is very different from that of a black body, and the value of the emissivity factor differs greatly from unity for particular wavelengths. In such circumstances, these bodies, when placed in a flame, will become considerably hotter than would a black body under the same conditions. The smaller the emissivity of a body in the infra-red portion of the spectrum, the more nearly will its temperature approach to that of the flame, and the greater will be the proportion of radiation emitted within the light band. This is the explanation of the action of the thoria-ceria Welsbach gas mantle. Thoria has a very low emissivity and radiates very much less energy than that of a black body at the same temperature, so that its temperature more nearly approaches that of the flame. On the other hand, the total radiation from thoria, even in the visible spectrum, is still very low compared with that of a black body, so that thoria alone is not a good substance for the production of light. If, however, a substance could be found which had an emissivity approaching unity in the visible region, but very low throughout the whole of the infra-red, this would constitute the ideal mantle material, since it would approach closely to the temperature of the flame gases. Ceria, when hot, has values of $E_\lambda$ approaching one in the yellow-green part of the spectrum, but the values in the infra-red, particularly around 4·5 $\mu$ are also high. Hence, although it is an efficient radiator in the visible region, it will not approach the temperature of the flame. By mixing ceria with thoria in suitable small proportions, however, a compromise may be effected and a material obtained which approaches the temperature attained by pure thoria, but also emits fairly well in the visible region.

Recent developments in physics and chemistry show that the temperature of a gaseous system in thermal equilibrium can be measured by the average random kinetic energy of the gaseous molecules. It is known, however, that, when gases undergo exothermic chemical reaction, the energy liberated does not always immediately appear entirely as an increase in this random kinetic energy of the molecules of the system. Part of the energy may be used up in raising the potential energy of some particular species, and a finite time may elapse before this energy is either given out directly as radiation, or "degraded" to normal thermal energy of agitation of the molecules generally. This may happen in several ways ; among them are the raising of the molecule to higher rotational, vibrational or electronic energy states, or the formation of a molecule or atom which is physically stable but chemically unstable, *i.e.*, it is capable of undergoing further exothermic chemical reaction. Any measurements of the temperature of such a gaseous system will give values depending upon whether or not the measuring instrument can interact with the unstable bodies concerned. As an example of this may be quoted the measurement of the temperature of a stream of hydrogen passed at low pressure through an electric discharge or over a heated tungsten wire, when the resulting gas contains a proportion of free hydrogen atoms. If two ordinary glass thermometers are inserted into the gas stream, the bulb of one being "poisoned" by an adsorbed film of water, and the other closely surrounded by platinum foil, the temperatures indicated by the two thermometers will be different. Hydrogen atoms do not re-combine on a glass surface on which water vapour is adsorbed, but platinum promotes the re-combination. Hence, the heat liberated, corresponding to the reaction, $2H \rightarrow H_2 + 100{,}000$ cal., is imparted to the second thermometer.

This is the principle upon which are based the researches of the Institution of Gas Engineers upon this subject, of which the preliminary experiments only are described in a report* by Mr. E. C. W. Smith, B.Sc. It is not known to what extent the radiation from normal flames is chemi-luminescent, but it appears certain that the emission of some lines from the flames containing salt vapours is greater than can be explained on purely thermal grounds. It is also known from spectroscopic evidence that certain chemically unstable species, such as the radicals CH, OH and $C_2$, are present in coal-gas flames ; and modern views of the mechanism of combustion suggest that oxygen and hydrogen atoms, and other radicals, such as $CH_2$, $CH_3$ and CHO, the presence of which has not yet been demonstrated spectroscopically, have a transient existence

* Second Arthur Duckham Research Fellowship Report, by E. C. W. Smith, B.Sc., on "The Radiation from Solid Substances under Flame Impact—Part I," presented to the Institution of Gas Engineers.

in the reacting system. It is necessary to find some substance which can interact with the "ordered" energy resulting from the elementary chemical reaction, before this energy is "degraded" to kinetic energy of the product molecules as a whole.

In 1842, W. H. Balmain prepared boron nitride and noted that it emitted a green radiation when in contact with the edge of a flame; and, in 1913, Donau found a similar result with certain specimens of calcium oxide, this phenomenon being known as "candoluminescence." Other experimenters have shown that this luminescence is due to crystalline structure, and that very pure specimens show very little luminescence. The principal work on the subject has been done by E. L. Nichols at Cornell University, and these researches are briefly summarised in the report. Nichols and his co-workers have found that luminescence was visible only over a particular temperature range, characteristic of the substance concerned, lying in general between 0 deg. and 700 deg. C., but in some cases extending to 1,000 deg. C. Experiments were also described by Nichols, which show that only the outer portion of the reducing zone of the flame was effective, and that only the pure hydrogen flame—and, to a lesser degree, flames containing hydrogen—caused the luminescence, while the flames of alcohol, ether and carbon disulphide were inactive. It was concluded that the effect did not depend on traces of activating elements, although these might modify the luminescence, or even inhibit it.

Nichols then extended his investigation to radiation from incandescent solids. In the light of subsequent criticism made in the paper here summarised, it is necessary to describe briefly Nichols' experimental procedure. The substance under test was placed side by side with uranium oxide on a refractory support and the two were heated by a symmetrically-disposed oxy-hydrogen flame. The temperature of the uranium-oxide surface was determined by observation through an optical pyrometer, employing the usual red screen. It was assumed that the substance under test was actually at the same temperature, while its apparent temperature was observed through the pyrometer, using a screen of any desired colour. These apparent temperatures then served as a measure of the brightness, $I_o$, of the surface at the particular wavelength passed by the screen. The brightness of the black body for the particular temperature and wavelength, $I_{BB}$, was calculated from the expression (1), given previously. The ratio $\frac{I_o}{I_{BB}}$ was then plotted against the temperature. It was claimed that, for many substances, this ratio passes through a maximum, which may be 5 to 10 units, or even more at certain temperatures in the range 1,000 to 1,500 deg. C. Experiments were also described which show that the radiation is subject to a fatigue effect. Figures were quoted for magnesium oxide viewed through the blue screen (wavelength 4,500 Å), and it was stated that while, 0·3 sec. after ignition, the ratio $\frac{I_o}{I_{BB}} = 65{\cdot}3$, after heating for some minutes the value became less than unity.

The author of the present report doubts how far candoluminescence is a luminescent effect, and believes that it may be due to straight thermal radiation. Nichols' deductions depend upon the assumption that the substance under test is at the same temperature as the uranium-oxide surface. If this is not correct, the conclusion that a luminescent effect was observed will have to be profoundly modified qualitatively, or even abandoned altogether. The author considers that the so-called "fatigue" effects are not inconsistent with a purely thermal explanation; continued heating will raise the temperature of the lower layers of the emitting substance and of its refractory support, this leading to an increase in the thermal conductivity of the materials, and hence to a greater heat loss and a lower surface temperature. Although the assumption of a considerable difference in temperature would explain the high values of $\frac{I_o}{I_{BB}}$ observed, it would not appear to furnish an explanation of the complicated temperature dependence of this ratio, and, in particular, of the fairly sharp maxima observed in the curves. These can only be accounted for by an abrupt change in either the infra-red emissivity or the thermal conductivity.

The author's experimental work was first directed, therefore, to the ascertainment of the difference in temperature (if any) between the two surfaces under the conditions of Nichols' experiments. Preliminary experiments have indicated that there is actually a very considerable difference in temperature, which may be as much as 200 deg. C. between the readings of two very fine thermocouples embedded, respectively, in each of the oxide surfaces. These results suggest, therefore, that the explanation of Nichols' observations is that the temperature of the white oxide is always higher than that of the uranium oxide (black body); but there is no simple relationship between the respective temperatures of the two oxides at any particular moment. This also follows from Nichols' observations of the relatively sharp crests in the $\frac{I_o}{I_{BB}}$ temperature curves. The results thus indicate that, within certain ranges, the temperature of the white oxide does, in fact, increase abruptly.

A more accurate experiment was undertaken, therefore, in which a depression in an alundum block was coated with the substance under test, and a single thermocouple, 0·001 in. in diameter, supported in contact with it. The oxide coating was then built up until the couple was coated by as thin a layer as possible, and a thin coating of uranium oxide was applied over the whole. The mass was slowly heated by an oxy-hydrogen flame, and allowed to attain thermal equilibrium at a particular temperature. Simultaneous readings of the optical pyrometer and the thermocouple e.m.f. were made, then the temperature was raised by adjustment of the gas supply and the readings repeated, and so on over the required temperature range. A very thin coating of the material to be tested was next applied, and a similar series of readings made. Finally, a further thin coating of uranium oxide was added, and a third set of readings taken. The two sets of readings with uranium oxide were then used to determine the correction to be applied at a given temperature to the thermocouple readings, to give the temperature of the surface as determined by the optical pyrometer for each thickness of coating. The mean of these two corrections was applied to the thermocouple readings for the white oxide, and hence a reasonably accurate value for its surface temperature computed. The corresponding value for the brightness of a black body at this temperature could then be calculated and compared with the actual brightness, as indicated by the optical pyrometer. Dividing the latter by the former gave a value of the emissivity of the substance at the particular temperature. This method was adequate to show conclusively that there is, in fact, no appreciable emission from these substances which can be regarded as of other than purely thermal origin.

Nichols' conclusion that luminescence does not depend on traces of activating elements is not in accordance with the views of German investigators, who believe that the phenomenon is essentially dependent on the presence of a small number of impurity atoms incorporated in the crystal lattice. The experiments of the present author confirm the necessity for the presence of an impurity. It was confirmed that the luminescence occurs only in the edge of the flame, while the temperature of the surface was between certain limits. The luminescence faded as the surface approached red heat.

It is evident that, even if a satisfactory luminescent material can be found by incorporating a small quantity of activator in suitable substances, the problem of the application of this method in practice will still be considerable. After many tests, the most satisfactory results have been obtained by allowing hydrogen to diffuse through a slab of porous brick, on the outer surface of which the luminescent material is placed. Very small flames form at each of the pores, and the whole surface is seen to glow brilliantly. An additional problem is to determine whether flames other than that of pure hydrogen will cause luminescence under these conditions. The results of the few experiments that have been made appear somewhat erratic and contradictory, since some specimens glow in the coal-gas flame in a satisfactory manner, though the intensity is in all cases much less than that in the pure hydrogen flame. Other specimens are apparently quite inactive in coal gas, and the glow is quenched by the addition of carbon monoxide to the hydrogen flame.

Further investigation will resolve itself into four main fields: (1) the examination of other substances, both as activators and as parent substances for the production of luminescent materials; as this work progresses, the periodic relation of the elements will serve as a useful guide in the selection of suitable materials. (2) The consideration of the problem of using the activating flame with the greatest possible efficiency, i.e., the design of a suitable burner and support for the luminescent material; also, the determination of the overall luminous efficiency of the various sources, the spectral distribution of their emission, and the use of gases other than hydrogen in the flame. (3) The elucidation of the mechanism of the process responsible for the luminescence, and the relation with cathode-ray and ultra-violet luminescence; this will probably involve experiments on the effects of atoms and active radicals produced in the exit gases of electrical discharges, and of radiation of very short wavelength. (4) The investigation of the anomalous thermal behaviour in the high temperature range by means of infra-red spectrometry.

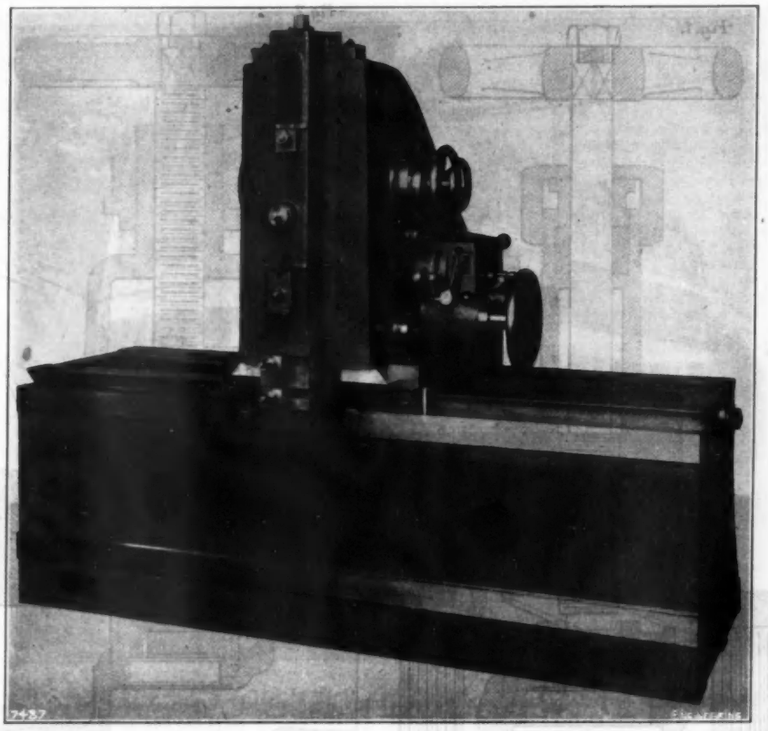
## THE WELDING, SOLDERING AND BRAZING OF HIGH-NICKEL ALLOYS.

Some interesting notes and directions regarding the oxy-acetylene welding, soldering and brazing of nickel and Monel, Inconel and other high-nickel alloys, are contained in a publication issued recently by Messrs. Henry Wiggin and Company, Limited, Grosvenor House, Park-lane, London, W.1. It is pointed out that a peculiarity of the high-nickel alloys, which, though perhaps present, is not nearly so marked in other materials, is the existence of a range of low tensile strength and brittleness between the temperatures of 790 deg. and 900 deg. C. Both above and below this hot-short range, however, the alloys regain their normal strength and ductility. On account of this, and also to facilitate the welding operation, the use of adequate jigs or skeleton frames, to hold in place the edges undergoing welding, are essential. When welding sheet and similar material, C-clamps are advocated for holding the jig together, so as to secure metal-to-metal contact between the jig and the sheet. In this manner the jig acts as a chill and absorbs heat which might otherwise warp the sheet. The oxy-acetylene flame employed should be very slightly reducing; in other words, the acetylene should be in slight excess to prevent the formation of oxides. It is recommended that, during welding, the end of the welding rod should always be maintained well within the flame, as oxidation results if the hot rod is brought into the open air. In order to secure maximum corrosion resistance in the finished work, the welding rods employed should be of the same composition as the alloy being welded. The most satisfactory flux for Monel metal is ordinary boric acid, applied by sprinkling on to the part to be welded or, in the form of a solution in alcohol, by means of a soft brush. Nickel, it is stated, needs no flux, but a special flux is available for Inconel.

Soft soldering provides a convenient and easy means of making joints where corrosion or contamination are not troublesome and where strength is not required. Ordinary plumber's solder (60 per cent. lead and 40 per cent. tin) is suitable and, when the work is clean, a neutral solution of zinc chloride will prove a satisfactory flux. It is stated that large numbers of tanks for use in the textile and other industries are regularly made up by soft soldering, and that tanks of light-gauge material may be fabricated by lock seaming and soft soldering. Tanks of light-gauge metal, 0·050 in. thick and lighter, may also be built up by lock seaming and silver soldering. Silver solder resists many of the corrosive conditions to which the high-nickel alloys are resistant and solder containing 40 per cent. of silver, 40 per cent. of copper and 20 per cent. of zinc is recommended. Borax gives good results as a flux and can be applied in the form of a thin paste. For brazing, an alloy of 50 per cent. of copper and 50 per cent. of zinc, using borax as a flux, gives good results. The strength and ductility of brazed joints are found to be reasonably good and the melting point of the composition recommended is above the hot-short range of the high-nickel alloy.

# TRAVERSING-HEAD SLOTTING MACHINE.

MESSRS. ORMEROD SHAPERS, LIMITED, HEBDEN BRIDGE.



## TRAVERSING-HEAD SLOTTING MACHINE.

THE traversing-head slotting machine illustrated on this page has been developed recently for the machining of plates in stack arrangements, but is obviously suitable for other applications. As the machine is driven by a built-in motor, it is self-contained, and this, together with its relatively light weight of 65 cwt., makes it convenient to move from site to site. The working floor space required is approximately 7 ft. 6 in. by 5 ft. 3 in. The machine is made by Messrs. Ormerod Shapers, Limited, Hebden Bridge, and the general construction will be clear from the illustration. The headstock carrying the slotting ram is traversed along a heavy base having numerous internal webs. The two machined strips seen on the front of the bed facilitate the accurate and rapid setting up of the work. The sliding ways on the top of the bed are angled at the outer edges to hold down the headstock on the bed. The ram is reciprocated from a large driving wheel and link motion of the closed-end type. The motor is of 4 h.p. and transmission is through a gearbox, which gives three changes of speed to the ram, viz., 28 strokes, 38 strokes and 56 strokes per minute. The length of stroke is variable from zero to 8 in., and can be altered while the machine is in motion. The speed and stroke changes are effected by the handwheels seen at the side of the headstock, a visible indication of the length of stroke being given by a pointer attached to the ram and moving over a scale on the face of the headstock. A table attached to the side of the headstock near the control wheels gives the cutting speed in feet per minute at the three rates of reciprocation and at strokes of 2 in., 4 in., 6 in. and 8 in. The ram can be altered in position relative to its slide in order to vary the vertical range of the cutting tool. The toolholders are of steel and are of the planer type. They are carried in a steel block dovetailed into the ram head and the thrust is taken by a serrated stop. The headstock can be adjusted as to overhang from the saddle for a distance of 12 in.

The headstock is power-traversed along the bed at any one of four rates provided by the gearbox seen to the right of the headstock. All the feed rates are reversible and a rapid power traverse is provided for quick setting, this traverse being arranged to operate in the reverse direction to the power feed at the time. The large wheel seen on the feed gearbox permits fine adjustment of the feed to be made by hand. The total traverse is 5 ft. 3 in. when the machine has a standard bed 7 ft. 3 in. long. All the controls are conveniently grouped so that they can be easily manipulated by the operator when in his normal working position. All the gears and shafts are provided with forced lubrication, the pump being positively driven and fitted with a filter and operating indicator.

## THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS, NEW YORK.

*(Continued from page 76.)*

### THE DAVID W. TAYLOR MODEL BASIN.

THE fifth paper delivered at the annual meeting of the Society of Naval Architects and Marine Engineers, held in New York on November 14 and 15, 1940, was presented by Captain Harold E. Saunders, U.S.N., and was a continuation of his 1938 paper describing the David W. Taylor Model Basin at Carderock, Maryland. The author stated that the new Model Basin had been placed in full commission in October, 1940, having been formally dedicated, on November 4, 1939, by Rear-Admiral A. H. Van Keuren, the Chief Constructor, in the presence of Rear-Admiral Taylor himself and of all Navy Department employees, both active and retired, who had served with him at the Experimental Model Basin and the Bureau of Construction and Repair. The Washington basin was being continued in operation as an adjunct to the Taylor Basin, at which, so far, only one of the three carriages was available for use.

The specification for the track on which the carriages ran required that the vertical deflection of the rails should not exceed 0·001 in.; that any rail should be removable and capable of re-alignment as necessary without disturbing adjacent rails or removing the studs used to attach the rails to the chairs; that the tops of the finished rails should lie concentric with the still-water surface in the adjacent basins, with a maximum variation of ±0·005 in.; and that the sides of the main rail heads should be parallel to each other and to a straight vertical plane through the centre of the basin, with a maximum variation of not more than 0·005 in. in either direction throughout their length. The rails and their supports having been machined away from the site, it was necessary to establish three sets of co-ordinates for erection purposes, namely, a straight vertical plane through the centre line of each of the four walls; a horizontal plane, curved slightly to conform to the curvature of the earth, over the top of each wall; and transverse planes, perpendicular to those mentioned, 8 ft. apart, for setting the individual supporting chairs. Although the specification allowed variations of 0·005 in., it was considered advisable to work to only 0·002 in. The establishment of a level plane concentric with the surface of the basin water was effected by using floats, carrying a levelling bridge, at each end of which was mounted a dial micrometer. Readings were taken in succession to the top surfaces of chromium-plated steel balls on top of steel posts, set at intervals in the concrete side walls. The vertical co-ordinate system was established by means of a 1,230-ft. aligning wire, slung between towers set up on the basin walls; a "working wire," stretched beneath it; and a plumb wire, hung from a portable tower support and making contact with the working wire and the bight of the aligning wire. The methods adopted for setting the chairs and rails were similar in principle, a microscope being used to check the position in relation to the tightly stretched working wire. The accuracy of the work was shown by the fact that, when the 150 rails were laid, with nearly 15,000 holes to slip over the studs in 575 chairs, not one rail hole had to be reamed nor one stud shifted. The rails were ground on the top, base and sides in a special grinding machine, capable of taking work up to 33 ft. in length. The shims under the rails were made in a single thickness, of rolled steel bar, and were also ground. Although the basin building had no windows or skylights, it was found necessary, for accurate levelling from the water surface, to shut down all ventilation fans, seal some of the ventilation openings and the water overflow openings leading to the drainage tunnel, and to use an air lock for access to the building. With the water surfaces shielded in this manner against air currents, it was found that the total wave height, when levelling was in progress, did not exceed 0·001 in.

### MARINE RADIO COMMUNICATION.

Mr. Irving F. Byrnes, chief engineer of the Radiomarine Corporation of America, delivered the sixth paper, which dealt with "Marine Radio Communication and Equipment." After outlining the development of the international agreements now governing marine radio frequencies and equipment, the author summarised the United States regulations, the principal basis for which, he stated, was the Communications Act of 1934, with subsequent amendments. The equipment required by law, however, was commonly exceeded; for example, about 1,300 direction finders were in use in United States ships, although only 112 of these were required by the law. The regulations provided that main radio-telegraph transmitters must have an output of at least 200 watts, and must be capable of operating on a minimum of four frequencies between 375 kilocycles and 500 kilocycles. The official requirements involved that the set must perform at least five basic functions: the conversion of the ship's supply, usually direct current at 115 volts to 230 volts, to the high-frequency current at the aerial; accurate maintenance of frequency with a variation not exceeding ±0·3 per cent.; the provision of means for modulating the carrier frequency; the keying circuit must ensure that the current delivered to the aerial circuit is completely started or stopped by means of the telegraph key; and the operator must be able to select quickly the desired operating frequency. The power supply for such a transmitter was usually obtained from a small three-unit motor-generator set. For emergency operation, the main transmitter could be used also as a 50-watt transmitter operating from a 12-volt storage battery. This was accomplished by means of a separate small motor-generator unit. Cargo vessels were required to carry an auto-alarm, to permit automatic reception of a distress call at times when the operator was not on duty. This device, which had been an important contribution to the safety of life at sea, was actuated by a special signal, based on international agreements and consisting of a series of dashes and spaces, each dash having a duration of four seconds, with spaces of one second. The auto-alarm used in United States ships was constructed to operate when four consecutive dashes and spaces had been received. The incoming signals were amplified and rectified by the receiver and operated a small high-speed relay, which, in turn, energised timing circuits in the selector. A stepping relay advanced one position for each correctly timed dash and space. After the receipt of four such signals, the stepping relay had advanced to its final position, at which it actuated a bell-ringing relay. This locked in, causing bells to ring on the bridge, in the radio room and in the operator's cabin. If extraneous signals, or static or other interference, caused the stepping relay to advance one, two or three positions before the sequence was interrupted, the alarm automatically reset itself. It was possible for the alarm to recognise the distress signal when interference

was present, so long as the interfering signal did not affect the length of spacing of the distress signal. Many classes of vessels, not required by law to have radio-telegraph apparatus, used the coastal radio-telephone service, working on frequencies between 2,000 kilocycles and 3,000 kilocycles. Radio-telephone communication had been extensively applied to cargo vessels on the Great Lakes. The apparatus developed for this service was unique, in that it employed both intermediate and high frequencies in order to obtain both short- and long-distance communication. Frequencies in the 2,000-kilocycle band were satisfactory for short-range working, though they were not so effective over the land or over fresh water as they were in the coastal harbour service, over salt water.

### AIDS TO NAVIGATION.

The paper on "Sound and Radio Aids to Navigation," by Commander I. L. Gill and Lieut.-Commander L. M. Harding, of the United States Coast Guard, which followed, might be regarded as complementary to that of Mr. Irving Byrnes. Following on the use of cannon and bells, the authors said, the compressed-air trumpet type of fog signal was introduced about 1855. Steam whistles were used after 1869, and were usually of the locomotive type; but the time required to bring them into operation, and the possibility of confusion with the whistles of passing vessels, led to their abandonment. The siren type of fog signal, using steam, dated from 1868. This type was still in use, employing compressed air at about 40 lb. per square inch. A more generally used type was the "diaphone," originally patented in 1903, comprising a brass cylinder containing a hollow piston. The piston reciprocated in the casing, the sounding medium (compressed air) escaping through annular ports in the piston and cylinder walls. The signal note began only when the piston had attained normal frequency and terminated with a characteristic "grunt," about 50 per cent. louder than the main blast. A later development was the two-tone diaphone. Diaphragm horns had been in use in the United States since about 1929. They operated with comparatively low pressure (9 lb. to 15 lb. per square inch) but could be made very effective by combining suitable different frequencies in duplex or triplex horn units, and the individual horns could be orientated to cover a wide arc of horizon. Electric air oscillators had been employed to some extent, but lacked distinctiveness; though an effective signal could be obtained by sounding simultaneously two or more units of different frequencies. Comparative tests showed that diaphones were audible at from 12 to 24 miles, according to type, and a 6-in. rotating air siren, at 16 miles.

Radio-beacon installations had increased in number throughout the world, from 23 in 1924 to a total estimated to exceed 500 at the present time. Concurrently, the number of direction finders fitted in ships had increased from 291 in 1924 to, probably, more than 10,000 in 1938. The number of available frequencies being limited, the beacons on the United States seaboard were grouped in threes, one group to each frequency. By an elaborate timing system, and automatic control, each beacon in a group emitted its signal for one minute in each three. The cost of establishing new radio-beacons at existing lighthouses was a simpler problem than that of finding frequencies for them to work on. Experience indicated that bearings could be obtained with an accuracy of ½ deg. to 2 deg., depending on the user, and the conditions on the ship and instrument employed. In 1929, at Cape Henry lighthouse, Virginia, there was established an apparatus for synchronising the sound-in-air fog signal and the radio-beacon. It had been received with favour, and about two-thirds of the United States radio-beacons had been fitted with the apparatus. The ship's operator listened to the radio-beacon transmission and, if the sound-in-air signal was operating at the same time, he heard a distinctive short-and-long signal during the radio-beacon transmission. He had then to time the interval between this distinctive radio signal and a duplicate of it, which arrived later from the sound-in-air signal. The interval in seconds, divided by 5, gave the distance in statute miles. The chief limitation of the system was the variable effective range of the sound-in-air signal under adverse conditions. It was improbable that the extensive system of sound fog signals and visual signals would be dispensed with completely, but the extending use of radio aids to navigation had diminished their relative importance considerably.

*(To be continued.)*

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RUBBER SHIPMENTS FROM BRITISH MALAYA.—The Malayan Information Agency in London states that ocean shipments of rubber from Singapore, Penang, Malacca and Port Swettenham, during December, totalled 69,565 tons. This was made up of 67,771 tons of rubber and 1,794 tons of latex in various forms.

# ARKON SEAT-IN-SLEEVE VALVES.

MESSRS. WALKER, CROSWELLER AND COMPANY, LIMITED, CHELTENHAM.

*Fig. 1.*

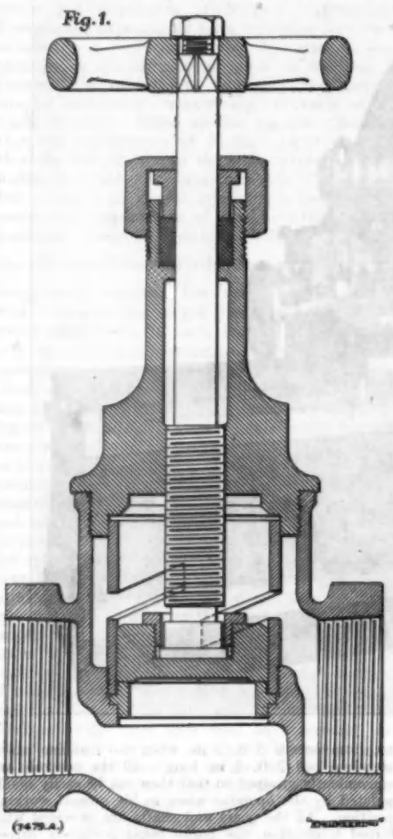
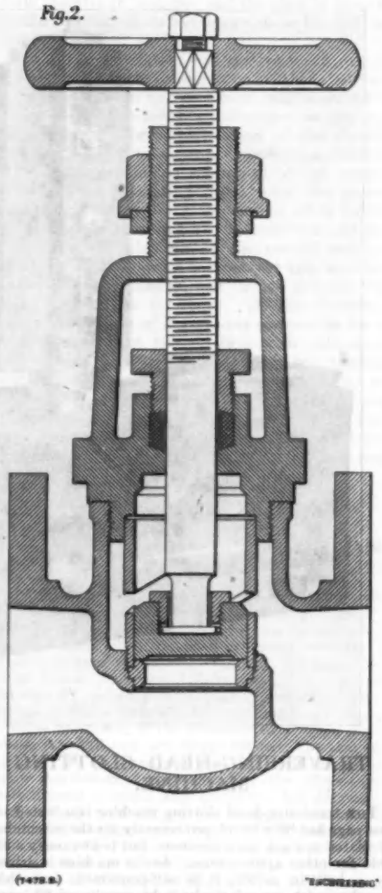


*Fig. 2.*



## ARKON SEAT-IN-SLEEVE VALVE.

THE valves shown in Figs. 1 and 2, on this page, have been designed to eliminate the troubles usually experienced in screw-down valves of the disc type when the disc is lifted from its seat by an amount sufficient to permit the passage of only a small quantity of steam, such fine regulation often resulting in erosion of both the disc and seat. The name of the valve, viz., the Arkon seat-in-sleeve valve, indicates the characteristic feature of the design, which is that the seat, instead of opening directly into the body of the valve, opens into a sleeve in which the piston-like disc is a close fit. The sleeve is provided with two helical ports, the bottom corners of which are some distance above the face of the seat, as will be apparent from Fig. 1. When the disc is lifted, therefore, it must be well clear of the seat face before any steam can flow, that is, the ports must be uncovered. The helical form of these ports naturally provides a fine degree of regulation as the area of the opening is at first only a small triangle, this area increasing rapidly as the lift continues. Any erosive action from the steam flow is confined to the edges of the ports, where it is of no importance.

As regards construction, the seat is of stainless steel and of Tee-shaped cross-section, so that it can be reversed. It is held down in the body by the screwed sleeve. The disc is loose on the spindle but attached to it by a screwed plug bearing on the spindle collar. A straight-through valve body is shown in both illustrations, although different types are manufactured. The type shown in Fig. 1 is intended for use with saturated steam at pressures up to 150 lb. per square inch. The spindle has an internal screw and the gland is provided with an ordinary nut. The type shown in Fig. 2 is designed for superheated steam at pressures up to 300 lb. per square inch and temperatures up to 650 deg. F. The spindle screw is external and works in a bridge the top of which is screwed to take the gland-tightening yoke. In both types the cover is screwed into the body. The valves are available, in all the usual pipe sizes, with screwed or flanged connections, and are made by Messrs. Walker, Crosweller and Company, Limited, Whaddon Works, Cheltenham.

## 105-H.P. TROLLEY-BUS FOR THE BELFAST CORPORATION.

THE illustration on the opposite page shows one of the 114 trolley-buses, which were ordered last year from the Associated Equipment Company, Limited, Southall, Middlesex, by the Belfast Corporation Transport Department. A number of these have now been completed and are due to go into service shortly. The new fleet consists of three-axle machines with an overall length of 29 ft. 7⅛ in. and a wheel base of 18 ft. 7⅛ in. The rear bogie axles are at 4 ft. 0½ in. centres, and the overall width is 7 ft. 5½ in. The chassis consists of a nickel-steel frame, with a maximum section 11¼ in. deep, and is inswept at the front to give a small turning circle of 62 ft. 6 in. All the cross-members are tubular in order to minimise distortion. The height of the frame from the ground is only 1 ft. 10¾ in. under full load, and a low floor level has been obtained by mounting the motor behind the legal 10 in. ground clearance area.

The casings of the rear axles are made from one-piece nickel-steel stampings and carry the worm gear in separate detachable housings which can be replenished with oil without entering the lower saloon. The axle-shafts are of the fully floating pattern and run on large parallel roller bearings. Both the worm gearing and differentials can be rapidly detached from the housings. The axle gear ratio is 10·33 to 1 and the worm centres are 8 in. apart. Three four-star differentials are used and these are fitted with renewable phosphor-bronze washers and floating bushes, thus ensuring even distribution of the driving and braking torque to all four rear wheels. The torque blade is made from chrome-vanadium spring steel and is carried in centrally-mounted brackets cast on each of the axle casings. The front and rear springs, which are fitted with adjustable phosphor-bronze bushes working on chromium-plated pins, are 4 ft. 2 in. long by 3½ in. wide and 4 ft. 9½ in. long by 3½ in. wide, respectively, thus ensuring good riding properties. Each rear spring swivels at its centre on large twin

# TROLLEY-BUS FOR BELFAST CORPORATION.

MESSRS. ASSOCIATED EQUIPMENT COMPANY, LIMITED, SOUTHALL.

needle-roller trunnion bearings. The steering is of the manufacturers' worm and nut type.

The electrical equipment for the trolley-buses was constructed by Messrs. The General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. It consists of a 105-h.p., 550-volt compound motor which is carried on a four-point flexible rubber suspension and drives a short stiff propeller shaft which has needle-roller bearing couplings. The propeller shaft drives the axle gearing, the gear ratio being 10·33 to 1, as already mentioned. Speed control is effected in the usual way by a pedal in the driver's cab.

Three types of braking are employed: Regenerative, which is controlled from the power pedal, rheostatic in conjunction with the air brake and controlled from the brake pedal, and a hand brake on the rear wheels. The foot brake, which operates on all six wheels, is actuated by compressed air. On the front axle the air cylinders are mounted directly over the hollow chromium-plated king pins, a form of design which eliminates any possibility of the steering being affected by the application of the brakes. A new design of high-lift brake cam is incorporated and it is said to be possible to wear out the ¼-in. liners without any resplining of the brake levers. The front and rear liners are 3 in. and 6 in. wide, respectively, and the total brake liner area is 716 sq. in. The reservoir governor, control valve, check valve and expansion chamber are carried on the air reservoir, an arrangement which permits the length of piping to be considerably reduced. By eliminating a number of connections it also cuts down the risk of pressure leakage. Air is maintained at a pressure of 85 lb. per square inch by means of a 5-cub. ft. compressor, which is driven by a ¾-h.p., 500-volt motor. This motor is insulated both mechanically and electrically from the chassis.

The bodies, of which half have shells by Park Royal Coachworks, Limited, Park Royal, London, N.W.10, and the other half by Metropolitan-Cammell-Weyman Motor Bodies, Limited, Broadway, London, S.W.1, are being completed by Harkness Coachworks, Limited. They are of all-metal construction and are designed to seat 68 passengers. Their general appearance will be gathered from the illustration. The exterior panelling is of steel, while the interior lining panels are of Sunburite. The waist panels are separate from the body side panels. A radiused mould of yellow pine covers the joint between the floor and side panels. The floor itself is of tongued and grooved red deal and slopes gradually towards the rear entrance to give the lowest possible step height from the platform. Tubular type seats are employed in conjunction with Dunlopillo cushions and back rests. Both are covered with hand buffed, crush grained hide of Belfast blue, the back rests having rep of a similar colour on their reverse sides. All the windows are provided with Triplex toughened plate glass. Two sliding windows of the Widney type are fitted to each side of the lower saloon. These assist the ventilation system, which comprises four intake and four extractor ventilators. The interior finish includes mouldings, window fillets, casings and cappings of metal, and stanchions and handpoles of Staybrite steel.

The platform, the back skirt of which is cut away to provide the necessary emergency exit, leads on to a side staircase which is fitted with steel stringers and Ferodo tread plates. In general design, the upper saloon is similar to the lower. As will be seen, the roof is of the domed pattern and is sheeted with aluminium alloy. It is provided with a concealed type of trolley-base gantry. A duck-board and platform give access to the collector gear and radio interference preventing equipment is also fitted. Three sliding windows are fitted on each side and these are supplemented by two half-drop windows in the front bulkhead. Ventilation is effected by means of Ashanco intake and extractor fittings on the front bulkhead and side eaves. Artificial lighting is supplied by 32 lamps, which are arranged on five circuits.

The driver's cab extends across the full width and is provided with a hide-covered Leveroll seat giving both vertical and horizontal adjustment. It is protected by a one-piece wind screen and two Ashanco ventilators are provided. Among the miscellaneous fittings are a cord-operated mechanical bell in the lower saloon and an electric bell which is operated by pushes on the staircase and in the upper saloon. The vehicles are finished in the Belfast Corporation's standard livery of blue and white.

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COMPANY REGISTRATIONS IN ENGLAND AND WALES.—The annual statistical report relating to new companies registered in England and Wales during the year ended December 31, 1940, prepared by Messrs. Jordan and Sons, Limited, 116, Chancery-lane, London, W.C.2, has now been published. This shows that 6,084 new companies, representing a total capital of 26,156,144*l.*, were registered during 1940. In the class designated "engineers," 706 companies, having an aggregate capital of 2,778,855*l.*, were registered; and in the electricity, gas, and water class, 159 new companies, with a total capital of 327,650*l.*, were registered. Sixty-eight new companies, with a capital of 172,201*l.*, are included in the mines and quarries class, and 116, with a capital of 287,746*l.*, in the metals section.

## WAR-TIME BUILDING CONSTRUCTION.

THE latest *Wartime Building Bulletin, No.* 12, which has now been issued by the Department of Scientific and Industrial Research, differs from its predecessors in that it deals with a particular problem rather than with generalities. The subject covered is the important one of emergency pipe repairs. It is pointed out that the standard peace-time method of jointing water and gas mains, which uses lead in one form or another, is a skilled and tedious operation. The shortage of skilled pipe jointers and the time required to do the work may cause serious delays in restoring services interrupted by enemy action. It is, therefore, important, as a defensive measure, to be able to use any alternative methods of jointing that are available, especially if these take less time.

The *Bulletin* brings together what is known both of thoroughly well-tried alternatives to lead jointing and others of a less established nature, which are worth trying under appropriate conditions. Obviously, all methods of pipe jointing are not suitable for every class of work. For example, the jointing of high-pressure water mains, where the head is commonly as high as 200 ft., and in some cases as much as 800 ft., presents problems owing to the risk of jointing materials being forced out from the joint. Willingness to depart from normal peace-time methods and a readiness to consider any method which is reasonably well adjusted to the circumstances, are, therefore, essential for effective war-time service.

The alternatives available are of two main types: those which are entirely mechanical and those which employ plastic or liquid caulking materials. The mechanical methods form an important group. In all of them rubber rings are compressed in various ways to form the seal. The joints are quickly made and are not only flexible (a very important point, since some settlement of newly filled ground must be expected), but so simple that operatives can learn the technique of even the most complex joints in a day or two at the most. Plastic fillings have the advantages of being quick and requiring no heat. Moreover, they can be applied to a pipe which is not dry and cannot be dried. The main drawback of these joints is that a little time is required for them to harden and during this period they have to be protected. On the other hand, the work can be done by bricklayers and plasterers when trained pipe-jointers are lacking. The poured fillings in this second group of alternatives have certain disadvantages for emergency repairs which may often render them unsuitable. For instance, they have to be melted and poured into the joint cavity, which must be dry. Once the joint is run and has cooled, however, it attains its full strength and the service can be restored forthwith. For this reason alone poured fillings merit attention in emergency repair work.

A full description of all the proprietary methods of jointing is given in the *Bulletin* and the time taken to carry out repairs is indicated. Considering pipe jointing methods and materials in relation to the injury to mains by high explosive bombs, it is recommended that full advantage should be taken of the mechanical systems of pipe jointing which are thought to provide the most speedy methods for emergency repairs. In establishing stocks of repair materials, reducers and bends will be required to suit the varying sizes of the existing mains in the system and a limited range of sizes of mains with mechanical joints will be required to run connections between the fractures. While it is obviously desirable that renewals should be made to the full bore of the main if possible, shortage of material or delay in its delivery, or shortage of labour, should not be allowed to delay the work. Where a smaller size, or a limited range of smaller sizes, is in stock, one of these can be used for the immediate repair and later, as opportunity allows, the full bore can be restored. The insertion of a short length of smaller bore pipe will reduce the pressure, but usually only by a trifling amount.

Where shortage of supplies or labour does not permit of immediate restoration by a particular method, all possible alternatives should be considered in relation to the pressure and contents of the main. Among pipe materials, the following are available:—Cast-iron, steel, concrete, and asbestos cement, all in various weights and designs. For joints there are various types of fully mechanical joint (spigot and socket) and couplings for plain end pipes, as well as various types of plastic material which can be used for jointing spigot and socket joints. Of these, cement and sand and rubber-latex cement composition are suggested as deserving prior consideration.

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TRANSPORT PROBLEMS IN NORTH YORKSHIRE.—Sir John Maxwell, Northern Regional Transport Commissioner, is forming a committee to investigate transport problems in the North Riding of Yorkshire, with particular reference to Tees-side.

## INSTITUTION ELECTIONS.

INSTITUTION OF CIVIL ENGINEERS.

*Associate Member to Member.*—Stewart Walter Cox, B.Sc. (*Glas.*), Gerrards Cross; John Cuerel, B.Sc. (*Bristol*), London, S.W.1.

*Associate Member.*—Sydney Charles Baker, London, S.E.25; Douglas Wilfred Blackmore, Colchester; Kenneth Bolton, B.Sc. (*Leeds*), Raunds, Northamptonshire; Geoffrey Cyril Raymond Carey, B.Sc. (*Belfast*), Bangor, Co. Down; William Roy Champion, Ealing; Ernest John Chesterman, London, N.W.10; Alfred Edward Chittenden, B.Sc. (Eng.) (*Lond.*), Sutton Coldfield; William Barnard Clark, Bridgwater; David Alexander Fleming Colville, B.Sc. (*Edin.*), Chatham; Brian Charles Alfred Cox, B.Sc. (Eng.) (*Lond.*), Langley, Buckinghamshire; James Arthur Dodworth, Bolton; Dermot Joseph Doyle, B.E. (*National*), Spa Tralee, Co. Kerry, Eire; Josiah Eccles, B.Sc. (*Belfast*), Edinburgh; Hassan Fahmy El-Baroudy, Ph.D. (Eng.) (*Lond.*), Cairo, Egypt; Ronald Harold Eveleigh, Radstock, near Bath; John Sithern Henzell, B.Sc. (Eng.) (*Lond.*), London, E.C.2; Edward Townsend Hippisley, M.A. (*Cantab.*), Leamington Spa; Roland Ralph Hole, Wokingham; John Baker Hoyle, Ilford; Percy Desmond Francis Tweedie Huss, B.Sc. (*Manch.*), Belfast; David Graham Illingworth, Kidderminster; Robert Johnston, Glasgow; Nathaniel Laird, Norwich; Robert William Langham, Lahore, India; George Herbert Lifton, Slough; Hardwin Alexander Littlepage, B.Sc. (*Birmingham*), Romsey; Stephen James McNamara, Penrith; Alan Frank Mason, Coventry; William Matthews, Birmingham; Digby Percy Cornwall Neave, M.A. (*Cantab.*), Fordingbridge; Edward Ogden, B.Sc. (Eng.) (*Lond.*), Nottingham; Frederick Russell Oliver, Hull; Herbert Norman Pring, B.Sc. (*Manch.*), York; Clarence Bertram Pyne, Manchester; Francis Stonier Rose, Stanmore; Robert Miller Ross, B.Sc. (*Edin.*), Featherstone; Pir Ghulam Jilani Shah, Bath; James Shelly, M.C., B.E. (*National*), M.Sc. (*National*), Maidstone; Gordon Soutar, Gidea Park, Essex; Henry Richard Tyrrell, B.Sc. (Eng.) (*Lond.*), London, N.10; John Crossley Waddington, Ealing; Lawrence Edwin Wall, Edinburgh; William Douglas Walshe, B.Sc. (Eng.) (*Lond.*), Pirbright; David Christie Watt, Dover; Hubert Henry Westbrook, B.Sc. (Eng.) (*Lond.*), Southport; John Edward Wheal, Alexandria, Egypt; Ernest Wilkinson, B.Sc. (Eng.) (*Lond.*), Secunderabad, Deccan, India; Michael Laurence Wolfe-Barry, B.A. (*Cantab.*), Fishguard; Alexander John Musgrave Young, London, S.W.2.

INSTITUTION OF STRUCTURAL ENGINEERS.

*Member.*—Maurice Henry Limb, A.M.Inst.C.E., Fetcham, Surrey; Cecil William James Spicer, Cheam.

*Associate-Member.*—Habaraduwa Kudabokola Melson, London and Ceylon.

*Graduate to Associate-Member.*—John William Leslie Dalton, Manchester; Duncan Milliken, Chorley.

INSTITUTION OF ELECTRICAL ENGINEERS.

*Associate Member to Member.*—William Ellis Affleck, Guildford; Charlie Alistair Britton, M.Eng., Chester; Major Hugh Clarke, B.Sc., M.Sc. (Eng.), 2nd Surrey Regt., R.A.; John Douglas Cockcroft, M.A., M.Sc. (Tech.), Ph.D., F.R.S., Cambridge; William Beale Cole, Ealing; Ralph Herbert Franklin, B.Sc. (Eng.), Teddington; Lancelot Gerhard Freeth, Shanghai; Leslie Greenwood, Stirling; William Herbert Grinsted, London, S.E.18; Cyril Thomas Holmes, Hull; Sidney John Husband, Ealing; Percy Howard Jackson, Birmingham; Bernard Leslie Metcalf, B.Sc., Pengam, Mon.; Reginald Charles Miller, Southampton; Albert Henry Mumford, B.Sc. (Eng.), Wembley Park; Tascar Alan Ross, O.B.E., London, S.W.1; Thomas Wylie Ross, Sale; Norman Turner Smith, Warrington; Harold Charles Wells, Buckhurst Hill, Essex.

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IRON AND STEEL CONTROL PROSECUTION.—The Iron and Steel Control, Ministry of Supply, has called our attention to a case recently brought before the Rochdale Borough Police Court, in which a local firm was fined on each of three charges, and also directed to pay costs, for having acquired quantities of re-rolled steel products without the authority of a licence issued by the Ministry of Supply. It was stated, on behalf of the Director of Public Prosecutions, that the charges related to the purchasing of re-rolled steel during February, March and April last. The total amount obtained, it appears, was 107 tons 1 cwt., whereas the defendants had been granted a licence for only 30 tons. Having obtained this quantity, it was their duty to apply for another licence. For the defence it was stressed that there had been no flouting of the objects of the regulations, which were to ensure that steel was distributed in the best national interest. The defendants had committed merely a technical breach by not sending their Return Forms in time to obtain a licence. The steel which they did receive had been supplied to persons engaged on work of national importance.

## BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

*Light-Output Test of Cinematograph Projectors.*—At the request of the Board of Education a technical committee has been set up by the British Standards Institution to specify methods for the measurement of the light output of sub-standard cinematograph projectors employing filament lamps. As a result of their labours, specification No. 930-1940, which describes a standard method of carrying out a field test for the light output of these projectors, has recently been published. Its purpose is to govern testing for light output only, no reference being made to picture steadiness, quality, freedom from flicker, and the colour content of the light, although these are factors which affect the apparent brightness of the picture on the screen. The specification is primarily intended for the assistance of those buying sub-standard projectors and will enable them to compare the light output of different types and also keep a check on any reduction in output after a period of use. The apparatus needed for the test is available in any physics laboratory.

*Headlamp Masks for Motor Vehicles.*—A new specification in the Institution's A.R.P. series, B.S./A.R.P. No. 36, relates to headlamp masks for motor vehicles. It may be recalled that certain requirements for headlamp masks are specified in the Lighting (Restrictions) Order, and a drawing of a recommended type of mask was issued by the Ministry of Home Security. This drawing was subsequently found to be inadequate, and it was felt that there was a need for a specification which would prescribe the optical performance of a mask but which would, at the same time, allow a good deal of scope to the designer. The present specification, which has been prepared at the request of the Ministry of Home Security, contains particulars of a headlamp mask which will secure compliance with the Order when the mask is properly fitted to a test headlamp, correctly adjusted on the motor vehicle and fitted with a bulb of the correct voltage and wattage rating. The specification actually goes beyond the requirements of the Order in that it defines not only the maximum illumination but also certain minimum illumination values, together with various constructional requirements. One of the most important features of the specification is that it provides, for the first time, a definite basis for the testing of the mask. The Lighting (Restrictions) Order prescribes that the illumination, produced on a vertical surface at any point 10 ft. from the lamp, must not exceed 2·5 ft.-candles, but it is not stated whether this amount of illumination applies when the vehicle is stationary or when it is running. If the full amount of light is given when the vehicle is stationary, too much light will be given when the engine is running at speed, since, in these circumstances, the voltage across the lamp will be higher than when the vehicle is stationary. The result has been that some of the masks placed on the market have contravened the Lighting (Restrictions) Order. This state of affairs, however, should be remedied now that the test conditions are clearly specified in the new publication. [Price 4*d.*, including postage.]

## BOOKS RECEIVED.

*Acceleration in Linkwork.* By W. R. THOMSON. London: Sir Isaac Pitman and Sons, Limited. [Price 21*s.* net.]

*Mitteilungen aus dem Institut für Baustatik an der Eidg. Technischen Hochschule in Zürich.* Mitteilung Nr. 11. *Beiträge zur Theorie und Berechnung von Balkenbrücken aus Eisenbeton.* By DR. MOHAMED HILAL. Stockerstrasse 64, Zürich 2: A. G. Gebr. Leemann & Co. [Price 15 Swiss francs.]

*Proceedings of the American Society of Civil Engineers.* Transactions Number. October, 1940. New York: American Society of Civil Engineers.

*Hiduminium Technical Data.* 89 Buckingham-avenue, Trading Estate, Slough, Bucks: High Duty Alloys, Limited. [Free.]

*Glossary of Metallographic Terms.* Compiled by PROFESSOR J. N. GREENWOOD. Melbourne: Tait Publishing Co. Pty. Ltd. London: Technical Bookshop, Salisbury House, London Wall, E.C.2. [Price 5*s.* net.]

*Derby Society of Engineers. Annual Report and Transactions.* Fifty-Sixth and Fifty-Seventh Sessions. 1938-39 and 1939-40. 45 Friargate Derby: Offices of the Society.

*The British Commercial Gas Association.* Industrial Uses of Gas Series No. 12. *Gas as a Fuel for the Light Metal Industries.* London: Offices of the Association, Gas Industry House, 1 Grosvenor-place, S.W.1. [Free.]

## PERSONAL.

SIR CLIVE BAILLIEU, K.B.E., C.M.G., has resigned the chairmanship of Messrs. Imperial Smelting Corporation, Limited; The Zinc Corporation, Limited; and New Broken Hill Consolidated, Limited, on being appointed Director-General, British Purchasing Commission. He has been succeeded in the chairmanships by MR. JOHN GOVETT.

MR. PERCY PRITCHARD has succeeded MR. P. H. MILLS as President of the Birmingham, Wolverhampton and Stafford District Engineering Employers' Association. Mr. Pritchard, who is Director of the Light-Alloy Castings Control under the Ministry of Aircraft Production, is joint managing director and deputy chairman of Messrs. Birmid Industries, Limited, Smethwick, and of Birmingham Aluminium Castings Company, Limited, and a director of other companies. Mr. P. H. Mills, who is managing director of Messrs. W. and T. Avery, Limited, is now Controller of Machine Tools.

The Rt. Hon. Oliver Lyttelton, D.S.O., M.C., M.P., President of the Board of Trade, has appointed MR. C. U. PEAT, M.C., M.P. for Darlington, to be his Parliamentary Private Secretary.

MR. R. F. HATTO, who has been with Messrs. S. Wolf and Company, Limited, portable electric tool manufacturers, Pioneer Works, Hanger-lane, Ealing, London, W.5, for 22 years, and was made a director last year, has been appointed general manager of the company.

MR. G. PARKIN has been placed in charge of the metallurgical laboratory and research department of Messrs. Edward Pryor and Son, Limited, steel marking-device manufacturers, West End Works, Sheffield, 10.

LORD ROTHERWICK, who is vice-chairman of Clan Line Steamers, Limited, and a director of Houston Lines, is the President-elect of the Chamber of Shipping of the United Kingdom for the ensuing year.

DR. WALTHER WOLFF, consulting engineer, informs us that his office has been transferred from Thanet House, 231, Strand, to 2, Norfolk-street, Strand, London, W.C.2. (Telephone, TEMple Bar 3206.)

MESSRS. SERVIAN MACHINE TOOLS COMPANY, LIMITED, 44, Brazennose-street, Manchester, 2, have established a branch at 90-92, Wells-street, South Melbourne, S.C.4, Australia, for the purpose of manufacturing and importing machine tools.

The Minister of Transport has appointed MR. R. HUGH ROBERTS to be the Regional Port Director for the Bristol Channel Region, which comprises all ports between Fishguard and Bristol. His functions are to co-ordinate the activities at these ports in order to secure the most rapid clearance of goods, whether inward or outward bound, the quickest turn-round of ships, and the best utilisation of available transport facilities. Mr. Roberts assumed his duties on February 12.

The Minister of Works and Buildings has appointed MAJOR-GENERAL K. C. APPLEYARD, C.B.E., to the post of Director of Emergency Reconstruction, within the Building Priority Department. General Appleyard's services have been lent by the War Office and by the Ministry of Labour and National Service, but it has been agreed, at the request of the latter Ministry, that certain of his activities in that Department will be continued by him.

## TENDERS.

WE have received from the Department of Overseas Trade, Millbank, London, S.W.1, particulars of the undermentioned tenders, the closing dates of which are as stated. Details may be obtained at the above address, quoting the reference numbers given.

*Tools* required by the mechanical and metal-work sections of trades schools, including twist drills, steel figures and letters, files, sledge hammers, micrometers, brass and steel rules, foundry shovels, stock dies and taps, vices, grinding wheels, engraving tools, spanners, pliers, portable forges, and a milling machine for brass engraving. Ministry of Education, Sharia El Falaki, Cairo; March 5. (T. 15,381/41.)

*Sensitive Paper and Chemicals*, comprising 4,045 rolls sensitive paper, 18 in. wide, for Photostat machine No. 3; 33 rolls sensitive paper, 14 in. wide, for Photostat machine No. 2; and 18 rolls sensitive linen paper, 12 in. wide and coated on both sides, for Photostat recording machine No. 2. Also 14,450 tins of developing powder and 18,455 tins of acid fixing powder. Controller-General, Survey Department, Giza (Orman), Egypt; April 1. (T. 15,506/41.)

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ABRASIVE PAPERS AND CLOTH EXPORT GROUP.—Mr. C. G. Oakey has been made chairman of the recently-formed Abrasive Papers and Cloths Export Group. Mr. R. W. Young is the secretary and the office of the Group is at the Emery Trades Association, 29 and 30, Broad Street-avenue, London, E.C.2.

## NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

*The Welsh Coal Trade.*—Regarding the question of transport of coal to inland users, it has now been announced that, as a result of a meeting between South Wales Coal Owners and an official of the Great Western Railway Company, a plan was devised which, it was hoped, would maintain an increasing flow of traffic from South Wales to various inland destinations. The basis of the scheme provided for a close co-operation between the two parties and, given normal conditions, it was expected that the volume of traffic handled would show a gradual expansion. As a result, South Wales should be in a better position than hitherto to benefit from the expansion in the inland industrial demand. To secure this end, passenger transport has been cut down in order to provide the facilities required for the transport of coal. The Great Western Railway Company, it was understood, had based its calculations on a weekly coal traffic equal to that of normal times, and every endeavour would be made to improve on that level. Collieries engaged in the trade would operate on a quota basis proportional to their past outputs, but the basis would be variable in accordance with the amount of coal the railway would be able to clear from time to time. A gratifying feature of the steam-coal market has been an improvement in the request for the dry descriptions. The improvement has been due partly to the bringing of the Eireann trade under control and the greater freedom with which the authorities were issuing the necessary licences for the dry rather than for the bituminous kinds, in an effort to curtail shipments of the latter sorts as much as possible. Home industrial buyers were displaying a keen interest in the high-volatile bituminous sorts, which were still scarce and strong. Foreign business failed to show any material expansion. A sustained request was maintained for cokes, which were well booked and firm.

## NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

*Iron and Steel.*—In order to increase output, Sheffield industrialists are making extensions to their works, with the result that local engineers are receiving numerous orders for all types of equipment. Among the large-scale plants on order are cold-rolling mills for non-ferrous sheets, a continuous rolling mill, a hot-strip finishing mill, hydraulic machinery and auxiliary equipment, forging presses, pumps, drop hammers, and special machines for welding and testing purposes. In addition, there is a growing demand for machine and small tools. Steady progress is being made in the medium branches. Business in agricultural machinery and parts is brisk, and there is every prospect of the demand increasing still further. Not only are home requirements substantially greater than they were a year ago, but export trade is also increasing. Electric plant, and high-grade steels used in the production of such equipment, are in strong demand. Electric traction motors are also being ordered on both home and overseas account. Makers of raw and semi-finished materials report little change. There is an active demand for basic-steel billets, and acid steel is a progressive line; the consumption of steel-making alloys is considerable. All types of scrap are moving freely, consumers having little difficulty in obtaining adequate supplies.

*South Yorkshire Coal Trade.*—Recent difficulties in transport have now been overcome and larger tonnages are moving from the collieries and merchant depots. Large quantities of industrial fuel are being supplied to steelworks and ironworks, and power stations are buying smalls and slacks for stocking purposes; the recent run on house coal has been maintained. There is an active market in foundry and furnace coke.

THE GISHOLT MACHINE COMPANY.—In order to meet the current heavy demand for turret lathes, Messrs. Gisholt Machine Company, Madison, Wisconsin, U.S.A., have re-opened their Northern Works, Madison, which were closed in 1930. This step will add 60,000 sq. ft. of floor space to the present works accommodation, and it is planned that operations shall commence in this plant on May 1. Full production will be attained by the middle of the year.

LLOYD'S REGISTER SCHOLARSHIP.—A scholarship offered by Lloyd's Register of Shipping, valued at 100*l.* per annum and tenable for three years, will be awarded in May on the results of a competitive examination, to be held by the Institute of Marine Engineers. The scholarship is intended to assist marine-engineering students to take a university course in engineering subjects. The age limit is 18-23 and the closing date for entries, April 8. Further particulars and entrance forms may be obtained on application to the Secretary, The Institute of Marine Engineers, 73, Amersham-road, High Wycombe, Bucks.

## NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

*General Situation.*—Commercial business with customers at home and overseas could be put through in considerable volume if more iron and steel were available for industrial requirements. The statistical position, however, is steadily improving. The aggregate tonnage output is being fully maintained and imports from the United States are increasing. The enforcement of the regulations, under the control of distribution scheme, is still necessary to ensure adequate deliveries where they are most needed, but the position encourages hopes of the early allocation of some additional tonnage for ordinary commercial purposes.

*Cleveland Iron Trade.*—There is an ample supply of foundry pig iron, mostly from the Midlands. Only very moderate parcels of Cleveland qualities are obtainable, and there is still no prospect of an increase of the intermittent output. Foundries are turning out a larger tonnage than has been the case for some time and are consuming considerably increased quantities of pig, although they are making extensive use of scrap. Somewhat larger parcels of pig are passing through second-hands, who, however, would be glad of an opportunity to deal with more substantial quantities. The fixed prices of Cleveland pig are based on No. 3 quality at 128*s.*, delivered in the Middlesbrough district.

*Hematite.*—The production of hematite is at a maximum, under the conditions now existing, and is eagerly taken up as it becomes available. The heavy make is supplemented by imports of American iron, parcels of which, however, are allocated only to consumers unable to use other products for the work on which they are engaged. Sellers state that, so far, the actual requirements of consumers have been met. The official quotations for local and American hematite are ruled by No. 1 description at 138*s.* 6*d.*, delivered to North of England buyers.

*Basic Iron.*—Basic-iron makers are desirous of increasing their stocks and are offering no tonnage for sale, as they expect the requirements of their own steelworks to increase still further. The nominal figure for basic iron is 120*s.* 6*d.*

*Foreign Ore.*—Consumers still have moderate stocks of foreign ore and imports are likely to increase. The greater use of native ironstone, however, is reducing the need for ores from overseas.

*Blast-Furnace Coke.*—Sales of Durham blast-furnace coke are on a small scale. The supply is plentiful, but sellers have well-filled order books and are not pressing business. The market values are at the level of good medium qualities at 35*s.* 6*d.* f.o.r.

*Manufactured Iron and Steel.*—Semi-finished iron and steel deliveries are keeping the re-rolling mills in full operation. The substitution of finished iron for steel for several purposes is proceeding satisfactorily. Steel-makers continue to operate their plant at full capacity. Engineering structural material is in less urgent request than formerly, and orders can now be accepted for early delivery, but the demand for most other commodities is unabated. Shipbuilding requirements involve an increased demand for plates and sections. Bar producers and sheet makers have as much work on hand as they can handle, and departments turning out railway requisites are busily employed. Soft steel billets are 12*l.* 5*s.*; hard billets, 13*l.* 12*s.* 6*d.*; joists and sections, 15*l.* 8*s.*; heavy plates, 16*l.* 3*s.*; and heavy rails, 14*l.* 10*s.* 6*d.*

*Scrap.*—Users of iron and steel scrap are still keen buyers. Heavy descriptions of material are in most demand and extensive forward contracts could be obtained.

GRITTING OF SLIPPERY ROADS.—It is stated in the *Monthly Bulletin of Road Information*, issued by British Road Federation, Limited, that special instructions have been issued by the Ministry of Transport to divisional road engineers on the subject of the proper gritting of roads. It is added that it will be useful if road users, particularly operators of commercial road vehicles, would immediately notify the highway authorities of any default in this direction, giving full information as to time and place. Such complaints should be addressed to the County Surveyor.

MOTOR VEHICLES WITH SOLID TYRES.—Under the provisions of the Motor Vehicles (Construction and Use) (Amendment No. 3) Provisional Regulations, 1940, recently made by the Minister of Transport, the previous Regulations, under which it was provided that all wheels of motor vehicles and of trailers which are equipped with tyres other than pneumatic tyres must have a rim diameter of not less than 670 mm., have been amended. The provision will not now apply until January 1, 1942, in the case of vehicles and trailers first registered on or before January 2, 1933.

## NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

INSTITUTION OF ENGINEERS-IN-CHARGE.—Saturday, February 15, 2 p.m., The E.L.M.A. Lighting Service Bureau, 2, Savoy-hill, Strand, W.C.2. Lecture: "Recent Developments in Electric Lamps and a Review of A.R.P. Lighting Practice," by Mr. R. Peleria.

MANCHESTER ASSOCIATION OF ENGINEERS.—Saturday, February 15, 2.30 p.m., The Engineers' Club, Albert-square, Manchester. Lecture: "Modern Developments in Mechanical Excavation," by Mr. A. H. Wade.

INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 18, 1.30 p.m., Great George-street, Westminster, S.W.1. Joint Meeting with the SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE (BRITISH SECTION). "Further Data Concerning Pre-Stressed Concrete: Comparison Between Calculated Stresses Registered During Tests," by Mr. T. J. Gueritte.

ROYAL SOCIETY OF ARTS.—Wednesday, February 19, 1.45 p.m., John Adam-street, Adelphi, W.C.2. Ordinary Meeting. "Methods of Paper Manufacture." by Dr. Julius Grant.

SOCIETY OF GLASS TECHNOLOGY.—Wednesday, February 19, 2 p.m., "Elmfield," Northumberland-road, Sheffield, 10. Ordinary Meeting. (i) "Flow of Gases in Natural-Draught Furnaces," by Dr. E. J. Gooding and Mr. M. W. Thring. (ii) A Specification for Sands for making Colourless Glass.

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY.—Wednesday, February 19, 2.15 p.m., The Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting. (i) "The Diazo Process of Reproduction of Scientific Papers," by Mr. H. D. Murray. (ii) "Photographic Methods of Reproduction as an Alternative to Printing Scientific Papers," by Mr. Norman Parley.

INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 20, 2.30 p.m., Savoy-place, Victoria-embankment, W.C.2. Ordinary Meeting for the transaction of informal business. *North-Western Centre:* Saturday, February 22, 2.30 p.m., The Engineers' Club, Albert-square, Manchester. "Electricity in Paper Mills," by Messrs. W. J. Mason and S. A. G. Emms.

JUNIOR INSTITUTION OF ENGINEERS.—Saturday, February 22, 1.30 p.m., 39, Victoria-street, Westminster, S.W.1. Ordinary Meeting. "Notes on the Mechanical Measurement of Liquid Flow (Water and Oil)," by Mr. A. S. Ladley.

## NOTES FROM THE NORTH.

GLASGOW, Wednesday.

*Scottish Steel Trade.*—But little change occurred in the conditions in the Scottish steel trade during the past week, but all consumers were prepared to take increased deliveries of steel whenever possible. All works are operating at full capacity and production has reached a record level. Activity is continuing in the shipyards and there is a steady demand for ship plates, etc., and boilermakers are consuming a considerable tonnage of boiler plates. Light steel is also in demand and makers of black and galvanised sheets have such heavy bookings that every ton produced is rapidly taken up. The following are the current quotations:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black-steel sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

*Malleable-Iron Trade.*—A very satisfactory demand is now being experienced by the malleable-iron makers in the West of Scotland and production is on a large scale. The re-rollers of steel bars have a considerable amount of business booked and the output is being maintained at a maximum. Stocks of semies are good and incoming supplies are very satisfactory. To-day's quotations are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

*Scottish Pig-Iron Trade.*—Owing to the conditions now prevailing among consumers of pig iron, local makers are finding some difficulty in maintaining deliveries. Steel-makers, in particular, are absorbing a heavy tonnage of hematite and basic iron and have to depend on outside sources to augment the local supply. All furnaces are being worked at full capacity, but supplies of raw material are ample to meet all requirements. The following are the current market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton, and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

# 60-KVA. HALF-CYCLE BENCH MOUNTING SPOT WELDER.

CONSTRUCTED BY MESSRS. METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, MANCHESTER.

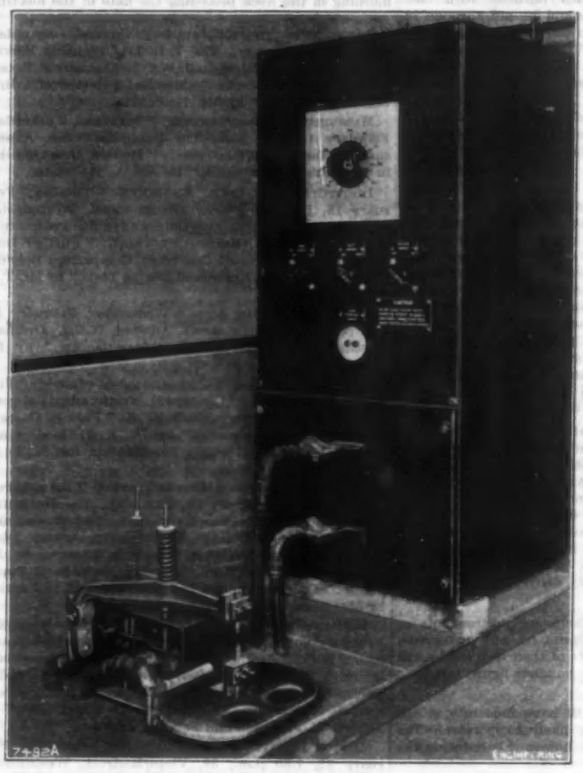

FIG. 1. WELDER AND IGNITRON CONTROL PANEL.

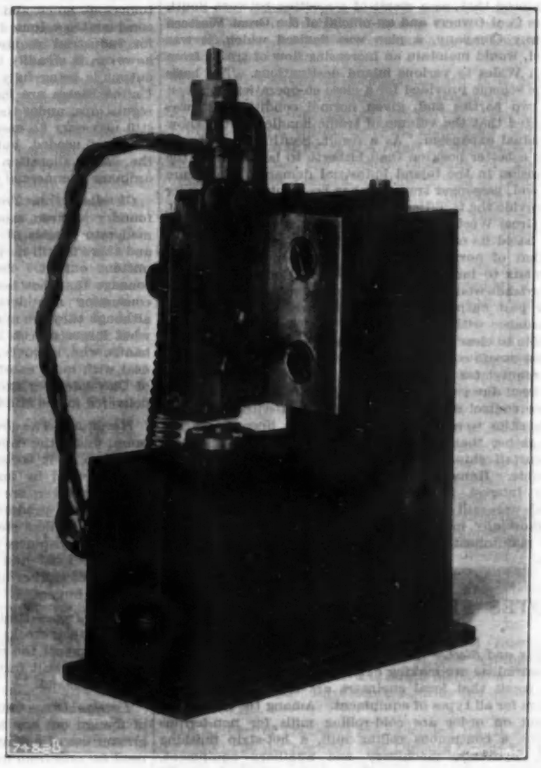

FIG. 2. JIG FOR USE WITH WELDER.

## 60-KVA. HALF-CYCLE BENCH MOUNTING SPOT WELDER.

As there are many classes of delicate work which cannot be spot-welded on conventional machines, a description of a special equipment which has been developed for this work by Messrs. The Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, should be of interest. In designing the welder, regard had to be paid to the following points: The material may be of such light proportions that extremely accurate control of all factors governing the weld is essential in order to avoid defects. The electrical conductivity of the material may be high, so that the resistance in the weld area will be low and a relatively large amount of electrical energy has therefore to be utilised before sufficient heat can be generated to produce a weld. In most bench-mounting machines the power available is small, so that the necessary energy input can be obtained only by employing relatively long welding times. The effects are adverse; either the heat has time to reach the surface and cause burning and excessive indentation or the prolonged heating affects the physical properties of the material in the neighbourhood of the weld. It is particularly important that these conditions should be avoided with plated or stainless materials. In addition, the electrodes heat up so that their life is considerably reduced. Moreover, they adhere to the work, particularly as it is generally impracticable to employ water cooling on such small machines. If the thermal conductivity of the material is high, the heat is conducted away from the weld almost as quickly as it is generated. This effect is aggravated in the case of thin materials by the proximity to the weld zone of the relatively large copper mass of the electrodes. The obvious method of preventing this heat dissipation is to apply the necessary amount of energy so rapidly that there is not sufficient time for the heat to be conducted away.

The 60-kVA half-cycle bench-mounting spot welder described below is a high-power precision-type machine which, by employing a weld period not exceeding one half-cycle of the supply frequency, enables the above factors to be taken into account. Fractions of a half-cycle may also be employed. The equipment, which is illustrated in Fig. 1, is connected to a 60-kVA welding transformer, which is capable of producing a peak secondary current of 9,000 amperes. The timing is effected by means of a metal Ignitron valve, which, as already mentioned, can produce any weld period up to one half-cycle of the supply frequency. No tap switch is provided for obtaining variation of the secondary current, which can be controlled from a single knob, thus dispensing with the necessity for manipulating two controls to obtain the correct combination. The only other adjustable feature is the electrode pressure, which is controlled by a finger nut on the larger of the two springs seen on the welder in Fig. 1. A switch incorporated in the welder automatically initiates the weld when the correct electrode pressure is reached. Finally, since the weld period is so short, water cooling is unnecessary.

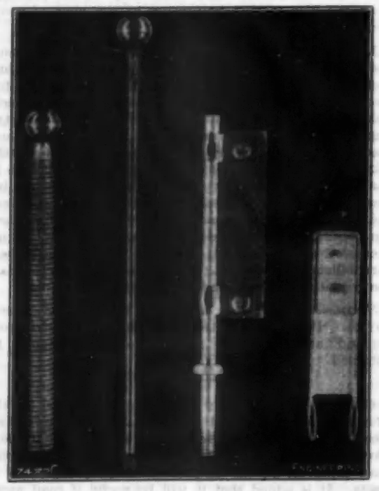

FIG. 3. SPECIMENS OF WORK.

It is claimed that, by using the welder with the half-cycle Ignitron control, it is easily possible to carry out many spot-welding processes which would be otherwise impracticable. This applies to both ferrous and non-ferrous materials and to thicknesses from a few thousandths of an inch to a total thickness of $\frac{1}{8}$ in., for equal thicknesses of work which can be welded with a minimum of marking. Where the work is of unequal thicknesses, welding is possible if the thinner material does not exceed $\frac{3}{64}$ in. in thickness.

Four examples of the work done on this welder are illustrated in Fig. 3, the reproductions being about twice full size. Of these, the third from the left is an assembly comprising a rectangular piece of mu-metal, $\frac{1}{64}$ in. thick, to which two nickel-silver hinges of 0·003 in. material have been spot-welded. The aluminium rod has been spot-welded to the hinges to prevent turning. The example illustrated on the right is of aluminium, about 0·01 in. in thickness, and the difficulty of welding this was increased by the fact that one of the pieces was formed with a protective oxide finish. The welds produced, however, were very neat and no splashing out of the metal occurred to spoil the appearance of the work. For the production of the part shown on the left in Fig. 3, it was required to weld a phosphor-bronze ball, $\frac{1}{16}$ in. in diameter, on to the end of a No. 8 B.A. steel screw, and in another case, shown in the adjacent example, a similar ball had to be welded on to a $\frac{1}{16}$-in. phosphor-bronze rod. It was particularly important not to mark or distort the ball as it formed a bearing surface, and to facilitate the work the jig illustrated in Fig. 2 was constructed. In this jig, an impression made in soft copper accommodated the ball and formed one electrode. The work produced was entirely satisfactory. Before the balls were attached by welding they had each to be drilled very accurately, and the rods passed through the holes and riveted over. The riveted parts were then ground off and polished. Small hard-steel balls have been welded to mild-steel handles for use as gauges by a method similar to that above referred to.

# THE WHEELER DAM AND POWE PLA

(For Descri page 121

Fig. 42. Line Drills in Operation; Early Stages of Work.

Fig. 44. Power Plant Foundation after Completion of Line Drilling.

# PLANT, TENNESSEE RIVER, U.S.A.

(Description, page 121.)

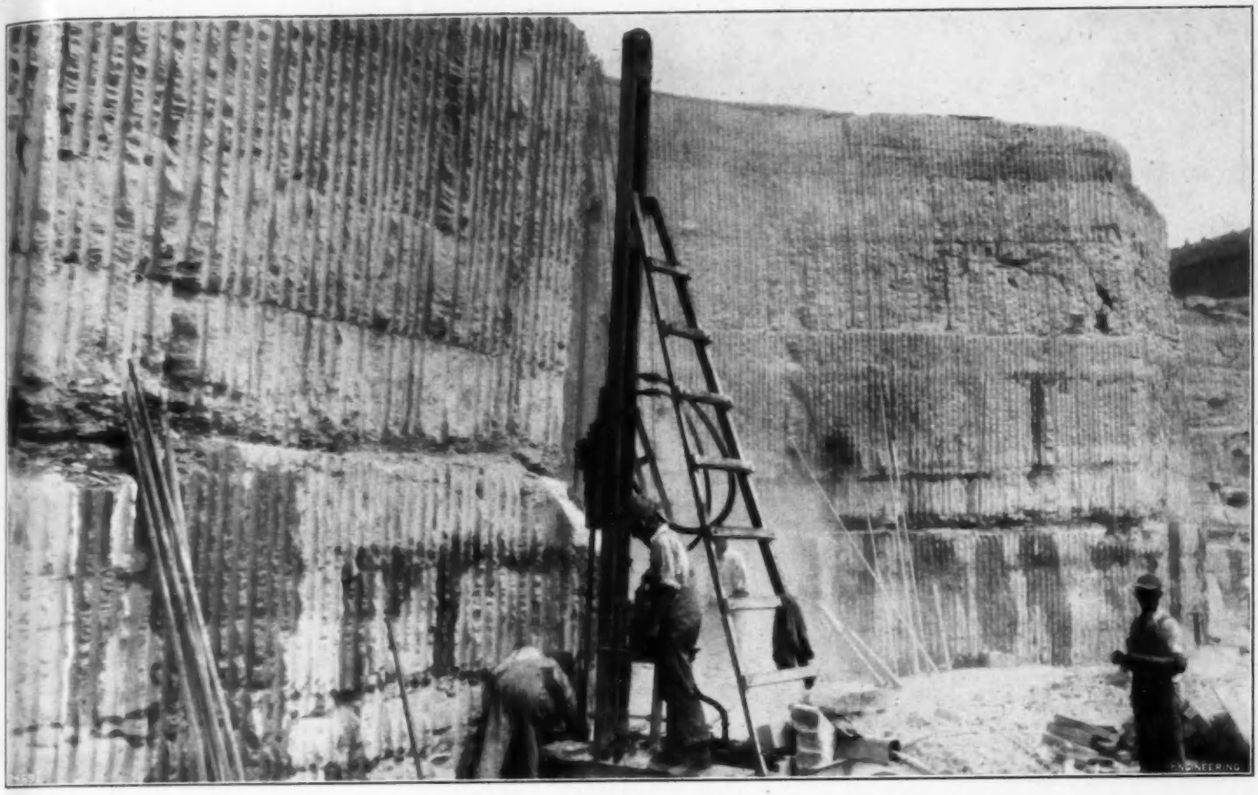

FIG. 43. LINE DRILLING IN PROGRESS.

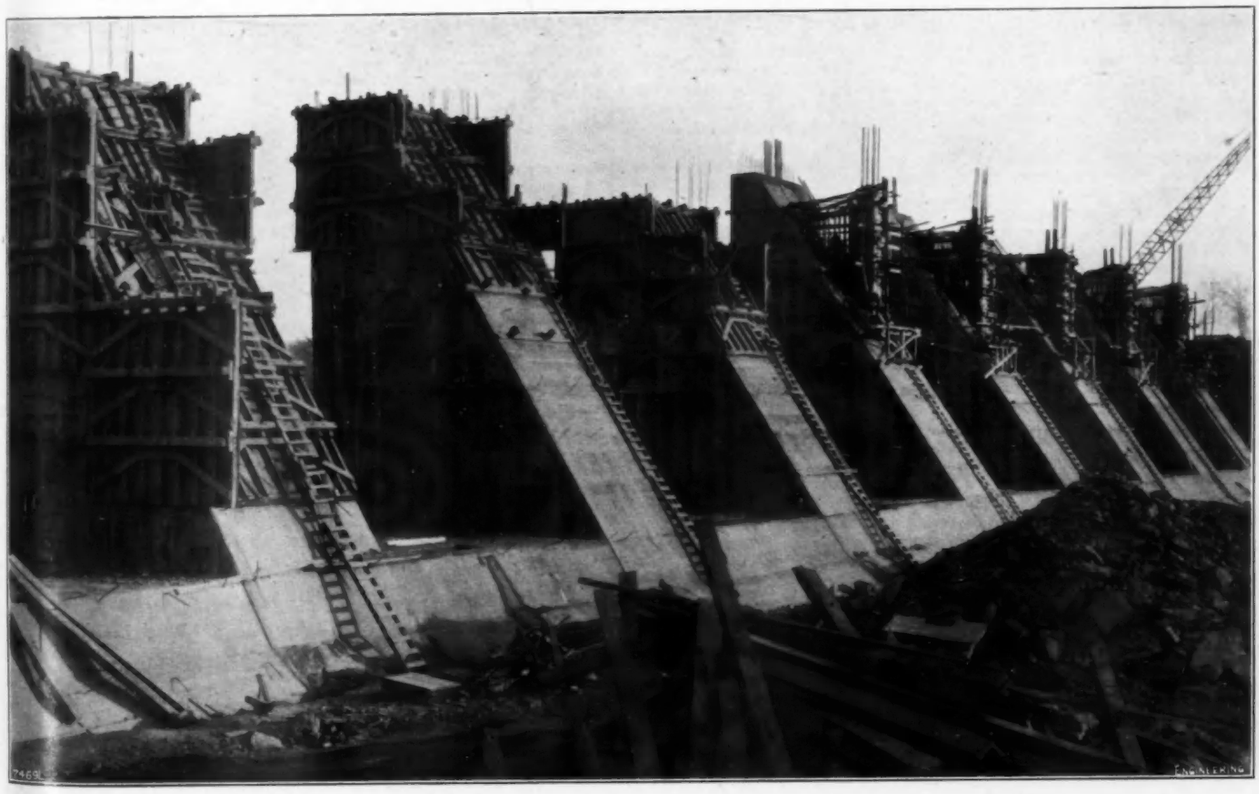

FIG. 45. SPILLWAY SECTION UNDER CONSTRUCTION.

UNIV. OF MICH.

# ENGINEERING.

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## TEMPORARY ADDRESS.

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## CONTENTS.


| | PAGE |
|---|---|
| Dam Construction in the Tennessee Valley (*Illus.*) | 121 |
| The Efficiencies of the Centrifugal Pump | 122 |
| Radiation from Solids under Flame Impact | 123 |
| The Welding, Soldering and Brazing of High-Nickel Alloys | 124 |
| Traversing-Head Slotting Machine (*Illus.*) | 125 |
| The Society of Naval Architects and Marine Engineers, New York | 125 |
| Arkon Seat-in-Sleeve Valve (*Illus.*) | 126 |
| 105-h.p. Trolley-Bus for the Belfast Corporation (*Illus.*) | 126 |
| War-Time Building Construction | 127 |
| Institution Elections | 128 |
| British Standard Specifications | 128 |
| Books Received | 128 |
| Personal | 128 |
| Tenders | 128 |
| Notes from the South-West | 129 |
| Notes from South Yorkshire | 129 |
| Notes from Cleveland and the Northern Counties | 129 |
| Notices of Meetings | 129 |
| Notes from the North | 129 |
| 60-kVA Half-Cycle Bench Mounting Spot Welder (*Illus.*) | 130 |
| Government Contracts and Costing | 131 |
| The Decentralisation of London | 132 |
| Notes | 133 |
| The Engineering Outlook.—III | 134 |
| *Letter to the Editor.*—District Heating | 135 |
| *Obituary.*—Mr. A. J. Makower. Mr. J. E. Willcox | 136 |
| A Post-War National Fuel Policy | 136 |
| Foot-Operated Air-Control Valve (*Illus.*) | 137 |
| Progress of Electrical Research | 137 |
| Labour Notes | 138 |
| Marine Engineering and the Classification of Ships (*Illus.*) | 138 |
| "ENGINEERING" Patent Record (*Illus.*) | 140 |

*One Two-Page Plate.—THE WHEELER DAM AND POWER PLANT, TENNESSEE RIVER, U.S.A.*



# ENGINEERING

*FRIDAY, FEBRUARY* 14, 1941.

VOL. 151. No. 3918.


## GOVERNMENT CONTRACTS AND COSTING.

THE recent disclosure by the Chancellor of the Exchequer, Sir Kingsley Wood, that the national expenditure directly chargeable to the conduct of the war now exceeds 10,000,000*l.* a day, aroused remarkably little public interest, proving once again how difficult it is for the average individual to comprehend figures so vastly in excess of any that he encounters in the ordinary course of events. In part, no doubt, the general calm acceptance of the statement was due to the realisation that there is little or nothing that the average individual can do to control such a tide of expenditure, much less to diminish it; but it is to be feared that the unresponsive reception was still more a sign that there is a limit to the figures that the ordinary mind can assimilate, just as there is said to be a limit to the amount of pain that the ordinary nervous system is capable of bearing. When that pain limit is reached, either the nervous reaction ceases to respond to further stimuli or unconsciousness supervenes. When the limit of statistical appreciation is reached, similarly, further accretions of figures cease to evoke any mental response.

It is well to remember, however, that these figures have a very definite meaning for future generations, whether the present generation appreciates them or not. Extravagance, like any other curse, has a knack of coming home to roost; and the old saying, "Clogs to clogs in three generations," is as likely to apply to a nation as to an individual member of it, with appropriate modification to the time interval, if the fundamental principles of economics are flouted and no effort is made to put the national house in order. War-time exigencies may call for desperate expedients on occasion, but not all of them are of so vital a character as to justify a complete disregard for the principles which peace-time conditions have shown to be sound practice. Some time and somehow, the war bill must be paid; and it is no more than the barest commonsense to see that the accumulation of debt shall be no larger than is absolutely unavoidable. In apportioning credit to those who are directing the national effort, therefore, a very considerable meed of praise is due to the members of the Select Committee on National Expenditure, for the eminently sound manner in which they are discharging the duty, put upon them by Parliament, of endeavouring to check waste at the source, and to ensure that the nation shall receive good value for the millions of money that it is spending.

The Fourth Report of the Select Committee for the present session, and the eighteenth in the complete series, deals with the terms on which Government contracts have been placed for war materials, including constructional work such as camps and emergency fortifications, and presents a most informative study of the special circumstances which may arise when urgency demands unusual efforts from industry. A distinction is drawn between constructional work of the type mentioned, and the supply of manufactured products, and a further division is made into five general categories, separate consideration of which, it is suggested, should have the effect of reducing interdepartmental competition. Other factors discussed, which are liable to influence costs, are the quality of the product, the quantity to be produced, the speed of output, and the efficiency of organisation. The types of contract considered are those on a fixed-price basis (which the Committee recommend should be adopted wherever possible, and to a much wider extent than at present) and those in the adjusted-price category, which may consist of (*a*) cost plus a percentage; (*b*) cost plus a fixed profit or a management fee; (*c*) maximum price; and (*d*) a "target" cost, with a limit on payment in excess of the "target."

The report, which is actually that of the small Co-ordinating Sub-Committee, adopted and presented by the main Committee, recognises that there can be no single form of contract which will meet every case, but it recommends very definitely that "cost plus" contracts should not be made for any work or product which is not novel in character, and, even then, only in the experimental stage, when accurate price-fixing is difficult or impossible from lack of previous experience which might serve as a guide. Maximum-price contracts should be associated, wherever possible, with a "target" figure below the maximum; and, in such cases, sufficient inducement should be offered to the contractor to effect savings. Otherwise, as stated, every effort should be made to place contracts on a fixed-price basis, and to this end full use should be made of data derived from previous experience and from investigations of actual costs. In applying the principle of competitive tendering, consideration should be given to the question whether this is, in fact, the quickest and most efficient means of arriving at a fair price; and, in particular, far greater use should be made of technical costing as a basis for future contracts placed by the Ministry of Supply, which, hitherto, has made little use of this method.

In dealing with the examination of costs, the report recommends that the Departments concerned should scrutinise labour costs more closely, to ensure that the labour charged to the contracts shall be employed in the most efficient manner; that there should be greater uniformity in the methods of allocating overheads, in groups of firms engaged on similar work under similar conditions; that costing systems already in use by contractors should be studied, and, where possible, accepted (subject to departmental "spot checks") in order to reduce separate departmental costing; that, where possible, process costing, rather than unit costing, should be used; and that contractors should be graded in accordance with the quality of their work, as a guide in the placing of further orders. Rates of profit, it is considered, should be related to the capital employed, and should be governed, where feasible, by agreements covering particular industries. To enable the fullest use to be made of the productive capacity of small firms, the "parent firm" and "embodiment loan" schemes should receive more extended application; the question

of credit facilities should be given further attention; all payments due should be made without delay, and, where final settlement is not immediately practicable, payments on account should be sanctioned as early as possible; and that the Treasury should give immediate attention to the question of the profits allowable to a contractor on sub-contracts. Other recommendations, of a more particularly departmental nature, concern the promotion of a more effective liaison between departments which are normally autonomous; better arrangements for the rapid collection, collation and application of statistical data; the unification of contract procedure, if necessary by the appointment of an *ad hoc* sub-committee, including officers detailed to study the market and trade information available; and that the respective spheres of the Supply and Contracts branches of the Admiralty, the Ministry of Aircraft Production and the Ministry of Supply should be reconsidered, "with a view to securing a more rational distribution of functions based on the general principle of reducing the number of departments dealing with the same industry or firm." In particular, it is suggested that the purchase of general stores, clothing and personal equipment should be the function of a separate new branch, and that, with certain exceptions, all constructional building should be the responsibility of the Ministry of Works and Buildings.

These are the general recommendations embodied in the report, but the mere summary does less than justice to a document which is always clear and forceful and occasionally becomes crisply epigrammatic. Indeed, some of its terser observations compare favourably with the business maxims which flower so exuberantly in the United States and are to be found, occasionally, even in the staid temples of British commerce. The disturbing feature, however, is that it should be necessary at this stage of war-time production, and with the experience of an earlier major war still recent enough to be generally remembered, to impress upon Government Departments such elemental principles as that "the prime necessity in a war economy is the maximum and most efficient use of manpower and materials," and that "it is a fundamental mistake to suppose that a form of output may be comparatively expensive in terms of money and yet cheap in terms of these real resources." Again and again do the Committee find it necessary to point out to the spending departments what should be sufficiently obvious. In some respects, perhaps, the departments have been forced by political pressure into courses which their executive heads know full well to be ill-advised, but which they cannot effectively vary. This probably explains to a considerable extent why, in recent years, the departments "seem to have concentrated almost entirely on reducing the contractor's profit rather than upon obtaining a cheap price."

On this question of profits, the report displays an admirable balance. "Although on general grounds it is most important to prevent either employers or employees making personal capital out of the nation's misfortunes," declare the Committee, "it is needful to preserve a sense of proportion. Even if profits are at a level as high as 10 per cent. of total costs, they represent only one-eleventh of the full price to be paid." For this reason, attention was particularly directed to "the application of sound contract principles to the remaining ten-elevenths." On the argument that Excess Profits Tax at 100 per cent. has removed the incentive to cheap production, they comment that this view, while not entirely correct, is supported by evidence; and "cheap production is vital to the successful prosecution of the war." This axiom might well have been included, with the shortcomings of the "cost plus" form of contract, among the lessons which "seemingly have to be relearnt in every period of national crisis."

The fact is, of course, that no form of contract, however, rigid, will make an inefficient firm into an efficient one; nor will a firm that is really efficient take advantage of a vague contract or lax official supervision. There are many old-established firms which have not felt the need of an exhaustive costing system in normal working; it may be that a more rigorous procedure, forced upon them by departmental pressure, may be for their ultimate good.

# THE DECENTRALISATION OF LONDON.

A RECENT issue of *Nature* contained a discussion of the position of London as the unquestionable focus of the scientific life of the British nation and Commonwealth; a status which was acquired because, for two centuries or more, scientists found a common meeting ground in the rooms of the Royal Society, while during the Nineteenth Century the capital also became the centre of numerous more specialised bodies. This centralisation has been assisted by the relatively small size of the British Isles and by the normal excellence of communications, two factors which make it easy for those who follow any special branch of science to meet in London. A blow to this policy of centralisation was delivered at the beginning of the war when the headquarters of many of London's societies were transferred to the country and the usual programmes of meetings were cancelled. When, however, attack from the air was delayed, a counter movement soon became noticeable, and, after Christmas, 1939, many societies resumed their meetings on almost a pre-war scale. During the present winter, following more intensive aerial attacks, some societies have again suspended their meetings, while others are holding them on a reduced scale at unaccustomed hours. The alternative of holding meetings outside London has also been adopted in some cases, though this arrangement does not promise to be very successful. Our contemporary did not reach any definite conclusion upon this matter, which must be conceded to be one of some importance. It is true that London is the focus of the scientific life of the British nation, as it is of many other national and imperial activities. The question is whether it is either necessary or wise that it should so remain.

The air attacks have proved at least one thing, if they have done nothing else. They have shown that those who have huddled together in large centres of population have exposed themselves to much greater risk from hostile action than those who, from necessity or inclination, live in the more sparsely-inhabited areas. One result of this has been the voluntary evacuation not only of school children but of Government offices and businesses, followed by repeated suggestions that all those who have no duties in London and other large towns should be compulsorily moved into country districts. It is felt, indeed, that one of the best ways of foiling enemy attacks is to spread the population over as large an area as possible. It is common knowledge that this policy of evacuation is attended by both sociological and physical difficulties. It is admitted, however, to be right in principle and might be made to work with fair efficiency. It is to be hoped that one result of the present struggle will be to indicate some solutions to the problems of modern existence which may be put into practice when peace has been declared.

Among these, this undue centralisation of the population might well find a place. It has already received some consideration. A Royal Commission was appointed to inquire into the subject in July, 1937, and in February, 1940, issued what were virtually three reports. These agreed that national action in tackling the problem was necessary and that a central authority should be established for the purpose. They differed about the powers and constitution of that body, which was, perhaps, only to be expected. In any event, it is less material to the present purpose than the fact that it was clear, even in peace time, that something ought to be done to amend the present state of affairs. War has emphasised both the importance and the urgency of the situation. It has also emphasised the fact that decentralisation is desirable, not only for industry, with which the report mainly dealt, but for Government departments, businesses, scientific societies and individuals.

Looking at the problem in the broadest way, it is clear, to quote the words of the report, that if some means could be found for distributing the industrial population, many of the factors which constitute serious handicaps on the strategical, social and economic sides, and even, in some respects, dangers to the nation's life and development, could be neutralised. The personnel engaged in a factory would generally follow that factory when it was re-sited, especially if adequate housing were provided in the new neighbourhood. This exodus would mean a corresponding migration of shop-keepers and others whose duty it is to minister to the needs of the employees, and a similar movement of officials, who, in increasing numbers, now play so large a part in our life. It would seem, however, that something more than this is required. Redistribution should be applied not only to the industrial population, but to the inhabitants of the country as a whole; some means should be found to counteract the magnetic force which London exerts, but before discussing the practicability of doing so it would be well to examine the nature of this force.

London is the capital city of a great country, and, in spite of the Statute of Westminster, of a great Empire. It is the "throne of Majesty," the headquarters of the Government in all its many departments, the largest port in the world, a centre of manufacturing and distribution, and the focus of what used to be called, and for want of a better word may still be called, Society. Being all these things, and more, it has acquired a prestige which attracts within its boundaries many of those who might as conveniently, and probably more comfortably, live elsewhere. How can that aggregation be broken up, both for its own benefit and that of the country? To begin with, the Government can show the way. Indeed, they have already done so. There are a number of sub-departments whose contact with Parliament (which it must be presumed will continue to sit in London) is of the slightest. The interests of many of them are more local than central, and they already deal with the public through local offices. They could well be moved into the provinces without loss of efficiency, since it may be presumed that, after the war, communications of all kinds will revert to their 1939 level and may even be improved. It is not necessary, either, that the headquarters of such concerns as railway companies should be in London, though they may regard it as convenient. The same applies to the Central Electricity Board, which has many points of contact with the public and other bodies in the provinces. The Port of London Authority and the Metropolitan Water Board are, of course, in another category. Many arguments could be advanced, however, for the transfer of the headquarters of scientific and technical societies to the provinces, not to speak of those charitable and other organisations which, though no less useful, are hardly of so capital a character.

By themselves, of course, such movements as these would do little to relieve the problem. What is required is a large-scale migration and redistribution of industry over the widest area, thus assisting to counteract the snowball effect to which the Royal Commission called attention, and which has resulted in the concentration of population in such centres as London, East Lancashire, the West Riding and the Clyde Valley. This would in time lead to an improvement in health, due to the absence of overcrowding and the increase in the effective sunshine available. Housing conditions would almost automatically become better and much of the money, time and nervous energy which is now expended in travelling between the home and the place of work would become available for other purposes.

These arguments could have been written almost equally well before the night of December 29-30, 1940, but the events of that night lend them support in two ways. The clutter of buildings which is the City of London forms a target so tempting to a ruthless enemy that it would be worth while to take some trouble to remove it. The destruction of property has imposed on many firms the necessity for rebuilding, and it is hoped that the result will be something more architecturally sound and better suited to modern conditions than that which has been razed. Is it necessary, however, for all those temporarily bereft of accommodation to be replaced on the same sites? Save for the loss of certain historic buildings, the "slum clearance" which has taken place has its bright side. If it results in a positive outward movement, it may even be a matter for eventual congratulation.

# NOTES.

### FUEL RESEARCH AT LEEDS UNIVERSITY.

IT is stated in the report, for 1939-40, of Professor D. T. A. Townend, who is in charge of the Department of Coal Gas and Fuel Industries of the University of Leeds, that, after an unsettling period due to the outbreak of the war, conditions became more normal, and, owing to the fact that most of the research activities of the Department are of national importance, they have been actively continued. When hostilities commenced, the investigations of the Joint Research Committee of the Gas Research Board and Leeds University on the high-pressure gasification of coal had reached a point at which the work of Dr. F. J. Kent, Dr. A. Key and Mr. J. W. Wood had enabled a survey to be made of the possibilities of its practical application as a source of town-gas supply. Moreover, the results of the work were sufficiently promising to justify the decision of the Joint Panel on Complete Gasification under Pressure, of the Fuel Research Board and the Joint Research Committee, to erect a semi-scale pressure vessel at Greenwich in order to confirm the characteristics of the process with plant larger than could be operated in the laboratory. The incidence of the war has rather hampered progress in this direction, but, on the other hand, considerable advances have been made in the investigation of certain complementary questions. These relate more particularly to the possible need of pre-treatment of a bituminous coal to overcome difficulties incidental to swelling, and the adjustment of calorific value, by catalysis, in gaseous systems comprising hydrogen, carbon monoxide, methane, steam and carbon dioxide. Further, the experience gained in the catalytic synthesis of methane from carbon monoxide and hydrogen, as part of the high-pressure gasification programme, has found application in connection with the possible use of methane, either compressed or in liquid form, as a war-time fuel for motor transport. In the coal-tar research section, laboratory work on road binders has been accompanied by road trials which, by now, have been of such duration as to confirm anticipations that certain disabilities associated with tars can be removed. Road surfaces laid in busy traffic thoroughfares in Leeds have shown marked superiority over those incorporating products of current type. Researches on the oxidation of special steels, on the properties and constitution of British clays used in the manufacture of refractory materials and fireclay ware, and on various aspects of combustion have been attended with fruitful results, some having direct application in actual industrial practice.

### ELECTRICITY SUPPLY IN WAR TIME.

The first effect of the war on the fortunes of electricity supply undertakings was unfavourable. The prohibition of street signs and lighting had an adverse influence everywhere, which was only slowly counteracted by an increased domestic consumption and still more slowly by greater demands for power. London, perhaps, suffered more than other parts of the country, and large provincial towns felt the ill-effects more heavily than the smaller. The ill-conceived rationing scheme might have made matters much worse, but, fortunately, it was abrogated before it could produce must effect. Now there are some signs that the worst is over. At East Ham, for instance, it is reported that, even during the year ended March 31, 1940, the total sales increased by 271,793 kWh to 34,308,734 kWh. It is true that this increase was accompanied by a fall of 10,564*l.* in revenue, owing to the decline in the sale of high-priced units to shops and business premises, but the final deficit was only 4,284*l.*, and it is probable that, by now, even this has been counteracted. At Inverness, 6,216,553 kWh were generated last year, the highest figure on record, though the average cost per unit generated was 0·1*d.* higher than in the previous twelve months, owing to increases in the costs of fuel, materials and wages, which indicates a position that requires watching. From Gloucester it is reported that increasing numbers of applications for stand-by supplies are being received, a state of affairs which requires consideration of the relations of the undertaking with the Central Electricity Board. A tariff problem has also arisen at Dumfries, where it has been customary for the County Council to levy a fixed charge of 5*s.* per quarter per room for domestic supplies. A number of the larger houses in the area have now been taken over for use as schools and, therefore, have to be treated as commercial premises, the fixed charge for which is 5*s.* per quarter per 100 sq. ft. of area. After some discussions, it has been decided to apply the latter charge in the cases in question, with the reservation that hard cases will receive sympathetic consideration. At Liverpool, a different type of war-time difficulty is to be met by charging consumers who have been compelled to use artificial lighting in their living rooms all day, owing to damage caused by air raids, at the rate of 1*d.* per kilowatt-hour instead of 3½*d.* for all electricity used in excess of the consumption for the corresponding period in the previous year.

### VACATION APPRENTICESHIPS.

The sixth annual report of the vacation apprenticeship scheme, organised in connection with the City and Guilds College Union, covers the year ended October, 1940, and shows that this method of obtaining practical engineering experience during the intervals of the College courses continues to receive full support, both from the students and from the large number of firms, consultants and public bodies who collaborate by taking the students into their offices and works. The number of students was 84 less than in the previous session, owing to the cancellation of the first-year course, but 144 registered, and arrangements were made for all of them to obtain this practical experience during the summer vacation. One of the students came from the Royal College of Science, and all the others from the City and Guilds College. Actually, accommodation could have been found for many more among the 113 firms and undertakings which offered to co-operate. The average payment received by the students is reported to show a slight increase, and once again many of the firms have expressed a desire to offer the students permanent employment on completion of their college courses. The honorary organiser of the scheme is Mr. J. Newby, City and Guilds College, South Kensington, S.W.7.

### PROFESSIONAL ENGINEERS AND MILITARY SERVICE.

It is interesting to note that the feeling is growing in the United States that there are better uses for students, research workers and teachers in scientific and professional fields than serving in the armed forces, especially in positions where no use is, or can be, made of their specialised knowledge. It is suggested in a statement issued by the United States National Research Council and the Sub-Committee on Military Affairs of the National Committee on Education that these classes of the community should be given deferred classification under the Selective Service Act. Six scientific fields are listed in which work is being done of such importance that those engaged in them are doing more towards national defence than if they were on active military service. These fields are :—Medicine and the allied professions, biological sciences, chemistry, physics, geology and related earth sciences, and engineering in all its branches. In support of this argument, the statement points out that "Experience of every nation engaged in the world war and the conditions under which it is being waged point directly to the necessity for proper employment of scientific personnel and of those competent to train such personnel, to a continuous supply of newly trained personnel and to the penalties incident to assigning them in large numbers to purely military service, where others without their special training can function equally well." Particular stress is laid on the desirability of students being allowed to finish their courses before they take up their military duties, because of the large demand for trained men in both the military and civil sections and because intensive specialised training cannot make up for a deficiency of qualified personnel. The university authorities are also asked to request the deferment of members of the teaching staff in the subjects mentioned who are essential properly to maintain the efficiency of the institution in the continuous training of students necessary in the operation of the defence programme or in the effective conduct of research and development problems assigned to the institution in connection therewith. The industrial laboratory and some graduate schools employ trained personnel often in group or team operations which require not only highly skilled individual scientific workers and engineers, but likewise men accustomed to working together in close co-operation. Subtraction of a single key man from such a group may seriously handicap or even destroy the capacity of the group to function. The problem of the industrial and university research laboratory concerned with a present or prospective defence programme is not merely one of retaining an adequate number of highly trained research men, engineers and skilled technicians, but also of maintaining the integrity of research and development teams.

### MOTOR FUEL PRODUCTION IN THE UNITED STATES.

In a review of the past year, Mr. A. J. Byles, president of the American Petroleum Institute, said that, while the production of motor fuel in the United States had increased from 611,043,000 barrels in 1939 to 614,450,000 barrels in 1940, exports had fallen from 44,638,000 barrels to 24,919,000 barrels. This, at first sight, somewhat surprising result he ascribed to the loss of the central European markets, strict rationing throughout most of the world outside the western hemisphere, availability of substantial Asiatic and South American supplies to Great Britain and her allies, Government embargoes on some products and the use of exchange credits for products not available elsewhere. Nevertheless, the ability of the industry to take its place in the national defence programme with fewer adjustments than many other businesses was indicated by the production figures for 1940. Not only was the industry ready to fill all anticipated needs for its own vitally important products, but it had begun commercial production from petroleum of synthetic substitutes for other essential substances. The chief of these were toluene, glycerine and rubber. The United States, alone among the nations of the world, could produce the quantities and qualities of super-aviation fuel required for maximum military effectiveness. Mr. Byles added that the average retail price of motor spirit in the United States fell to its lowest level in 1940, except for 1933, since prices were first tabulated in 1919. The figure was 12.75 cents per gallon, though the high tax, which averaged 5.66 cents per gallon, kept the cost to the consumer at a high level. The average motor vehicle, it was estimated, consumed 740 gallons of fuel in 1940, compared with 500 gallons in 1920.

### THE LIFE OF TRANSFORMERS FOR SWITCHGEAR TESTING.

IN ENGINEERING of October 9, 1936, we gave a description of the plant which had been established by the Switchgear Testing Company, Limited, at Trafford Park, Manchester, for the proving of circuit breakers with rupturing capacities up to 2,500,000 kVA. This included a heavy-current testing transformer bank consisting of three single-phase units, designed for a primary voltage of 11 kV, and secondary voltages of 2·2 kV, 1·1 kV and 0·55 kV from sectionalised windings. A three-phase initial output of 350,000 kVA asymmetrical and 250,000 kVA symmetrical could be obtained at all three voltages. The Metropolitan-Vickers Electrical Company, Limited, who were the manufacturers of these transformers, state that the opportunity was recently taken, during a lull in low-voltage testing work, to lift them out of their tanks for examination. It was then found that no overhaul was necessary, in spite of the fact that the windings had been repeatedly subjected to very large short-circuit forces during the four years' service. The winding clamps and screws were examined and tightened, when it was found that only very slight shrinkage had to be taken up—in no case more than ¼ in. on the axial length of the winding. The transformers are of shell-type construction with rectangular coils, the three units being in one tank.

# THE ENGINEERING OUTLOOK.

## III.—Aircraft.

Even in peace time the British aircraft industry was overwhelmingly dependent on military orders, and, with the control of exports and the great reduction in civil flying resulting from the war, this dependence has, of course, substantially increased during the past year. This fact has clearly caused a good deal of anxiety in the industry regarding the outlook on the cessation of hostilities, and, in the early part of 1940, the chairmen of several companies interested in the civil and export markets drew attention to the need for maintaining exports as far as possible. It was pointed out that the course of the war in its early stages provided considerable opportunities for those manufacturers who were in a position to carry on export trade mainly owing to the elimination of German competition. In fact, quite a considerable export trade was maintained during the first four months of the war, though the aircraft exported probably comprised mainly military types, sent to allied nations, and civil aircraft ordered before the outbreak of war, of types which could not assist in any way the war effort of this country. As shown in the accompanying Table I, the total exports of complete aircraft, engines and parts in 1939 were valued at 5,746,000*l.*, compared with 5,407,000*l.* in the previous year. The number of complete aircraft exported, however, fell from 506 in 1938 to 481 in 1939, and of engines, from 862 to 769; so that, even allowing for a probable price increase between the two years, it would seem that exports during 1939 consisted of more elaborate types than in the previous year.

During the first four months of the war, the value of total exports averaged about 360,000*l.* a month, compared with a monthly average of about 540,000*l.* during the first eight months of 1939.

After the fall of France, there was, of course, a material change in the situation, and, in view of the necessity of devoting all the manufacturing resources of the country to building up the strength of the R.A.F., it seems virtually certain that there must have been a drastic curtailment of exports. In these circumstances, probably the best insurance which this country can provide, in order to ensure a competitive position in export markets at the end of the war, is to take all possible care to maintain the development of civil types at the highest possible level. In spite of certain steps which have been taken with this object, however, there has been a good deal of criticism of Government policy in relation to civil aviation. It has been pointed out that, for reasons of prestige and propaganda, but more particularly in the development of export trade, civil aviation can make a very substantial contribution to the war effort. This has been recognised by Germany and Italy, who are maintaining existing services and developing new ones; from which, incidentally, they derive substantial advantages in connection with blockade running. Difficulties in providing aircraft and personnel, it is pointed out, should be no greater in this country than in Germany.

Speaking on the Air Estimates in the House of Commons in March, Sir Kingsley Wood was not encouraging regarding the future of civil aviation during the war. He claimed, however, that, in spite of the exigencies of war, the Empire services of Imperial Airways had been carried on without interruption. In conjunction with the Australian and New Zealand Governments, it had been decided to link up New Zealand with the Empire routes and to start, in April, a weekly service across the Tasman Sea. To safeguard the position of civil aviation after the war, he proposed to set up a strong Civil Aviation Advisory Committee, to review the state of civil aviation in the light of the existing situation and to plan for the future. This Committee was to have associated with it a small body of experts, whose task it would be to keep in close touch with all phases of technical development abroad. It was claimed that, in many respects, the development of civil aircraft ran parallel with that of military types, and that the intensive development of the latter under war conditions could readily be applied to the improvement of civil types when the opportunity occurred.

At the beginning of April, the British Overseas Airways Corporation, the formation of which was mentioned in this series last year, took over Imperial Airways and British Airways. The intention had been that the Corporation should make a public issue of stock, with preferential treatment for shareholders in Imperial Airways and British Airways; but, in view of war conditions, it was decided to raise the money privately and to pay out the shareholders in cash. It was stated that if the Corporation should decide at a later date to make a public issue of stock, shareholders in British Airways and Imperial Airways should be given the first option to subscribe.

The entry of Italy into the war, and the collapse of France, closed the usual route to the East, and a new route to Africa had to be opened up. This calls at Lisbon and then proceeds to Bathurst in Gambia; a distance of 1,900 miles, roughly equivalent to a North Atlantic crossing. After some delay caused by the preliminary negotiations, a regular service was established to Lisbon, thus linking up with the Pan-American Clippers. The difficulties of obtaining the new aircraft which were already overdue when war broke out were somewhat alle-

Table I.—*Export of Aircraft, etc.*

| Year. | Complete Machines. | | Engines. | | Total Exports. (Machines, Engines and Parts). |
|---|---|---|---|---|---|
| | No. | Value. | No. | Value. | |
| | | £000. | | £000. | £000. |
| 1930 .. | 317 | 601 | 552 | 539 | 2,050 |
| 1931 .. | 304 | 779 | 362 | 413 | 1,860 |
| 1932 .. | 300 | 641 | 451 | 467 | 1,741 |
| 1933 .. | 234 | 475 | 409 | 448 | 1,466 |
| 1934 .. | 298 | 747 | 478 | 592 | 1,922 |
| 1935 .. | 453 | 1,215 | 652 | 696 | 2,726 |
| 1936 .. | 448 | 1,285 | 625 | 741 | 2,924 |
| 1937 .. | 506 | 1,911 | 588 | 633 | 3,676 |
| 1938 .. | 506 | 2,462 | 862 | 1,173 | 5,407 |
| 1939— | | | | | |
| January-August | 481 | 2,511 | 769 | 1,199 | 5,746 |
| September-December | — | — | — | — | 4,308 |
| 1939 .. | — | — | — | — | 1,438 |

viated by the use of landplanes from the K.L.M., under charter to British Airways.

The problem of purchasing new civil aircraft has been a difficult one for most countries, since, as a result of the war, virtually the only source of supply has been the United States, and even this source may now be considerably restricted owing to the organisation of the United States industry for the maximum production of military types. In April, it was announced that the South African Government were to purchase 31 new aeroplanes from the United States, at a cost of 450,000*l.*, for commercial purposes. These were designed, however, to assist the South African war effort, as it was stated that, as soon as they were delivered, all the Junkers aircraft previously in service would be taken over by the Defence Department. The South African defence authorities were also reported to be making inquiries with a view to the purchase of additional military aeroplanes, of which a few heavy bombers, as well as a number of high-speed pursuit and fighter aircraft, were required.

Returning to the question of civil aviation in this country, strong complaints have been put forward of the treatment of the independent companies operating internal air lines. At the outbreak of war a sub-department of the Directorate of Civil Aviation was formed, called National Air Communications, and all air lines were formed into three groups under its control. One of these groups comprised the two companies operating the overseas routes, the second comprised the railway-owned interests, and the third, the remaining internal air services, comprising some ten companies. It was claimed that, whatever may have been the Government's intention, the policy actually pursued was likely to result in a virtual monopoly of the internal air services being conferred on the railway companies; and that, owing to their long established interest in other forms of transport, the railway companies were not the best authorities to be entrusted with the development of civil aviation in this country. It was further pointed out that the Air Ministry proposed to purchase the aircraft of the independent companies at a price based on their secondhand value as at August, 1939; that their pilots and staffs were being absorbed into other employment; and that no compensation was to be paid for the goodwill which the companies had built up.

There has naturally been little information published regarding the output of military aircraft in this country during the past year. In March, in the speech already referred to, Sir Kingsley Wood stated that, during the previous six months, the output of the single-seater fighter types—the Spitfire and the Hurricane—had doubled, and that of the larger bomber types, which involved a far greater number of man-hours, had been increased over the same period by more than 50 per cent. This statement, however, is of little use as a guide to the trend of total production, since the output of certain obsolescent types probably declined over the same period. Sir Kingsley Wood went on to say, however, that he took the view, with some confidence, that, even on a numerical basis, the output of aircraft accruing to Great Britain and France was in excess of that of Germany. Several estimates have been published of German output during the past year, but the most probable figure for production in the spring was probably about 1,800 per month. The phrase "aircraft accruing to Great Britain and France" presumably included deliveries to both countries from the United States, which were probably, at that time, between 150 and 200 aircraft a month. After deducting the estimated French production, therefore, it would seem that the monthly output in this country must have been approximately 1,300 machines.

There appears to have been considerable doubt as to the true position, however, since President Roosevelt, in June, referring to the aircraft production rates of the belligerent powers, asserted that one belligerent was producing at that time far more aircraft than the other two together. This statement probably excluded the aircraft being received by the Allies from the United States, but, even so, the latter would hardly be sufficient to bridge a gap as large as that inferred. On the other hand, confirmation of the estimates made above has been provided by some figures put forward by Mr. T. P. Wright, vice-president of the Curtiss-Wright Corporation, who made an inspection of aircraft factories in Great Britain, France and Germany just before the outbreak of war. He concluded that, if the aircraft from the United States were included, the Allies were receiving, in April, more aircraft than the Germans. His figures suggest that, in April, about 1,850 aircraft were accruing to the Allies each month, of which the British output represented about 1,250, while he put the German output at 1,750 per month.

In April, various changes in organisation were made at the Air Ministry with the object of securing a substantial increase in output. Sir Charles Craven was invited to join the Air Council as Civil Member for Development and Production, and to become chairman of the Air Supply Board, which was set up to replace the existing Air Council Committee on Supply. It was intended that the Air Supply Board should be responsible, under the Air Council, for the production of aeronautical equipment and supplies. Shortly afterwards, Brigadier-General H. A. Jones was appointed Controller of Light Alloys and, at the same time, powers were taken by the Secretary of State for Air, under the Defence Regulations, to control the fabrication and distribution of light alloys.

Shortly afterwards, the supreme importance of an acceleration of production was recognised by the setting up of the Ministry of Aircraft Production, and the new Minister (Lord Beaverbrook) at once took a number of steps to ensure better co-ordination within the aircraft industry. For example, the Nuffield aircraft factory, which had been erected for the construction of Spitfires, and the Vickers Supermarine Company, the original designers of the Spitfire, were brought together under one management and control. At the beginning of May, Mr. T. C. L. Westbrook, formerly general manager

of the Vickers-Armstrongs works at Weybridge, was appointed Director of the Aircraft Civil Repair Organisation. At about the same time, Lord Beaverbrook appealed for a large number of fitters to volunteer for erection and assembly work in aircraft construction and repair factories. The appeal was addressed particularly to garage hands, and is understood to have met with a very satisfactory response. Later, following the critical developments in France, all employees of aircraft factories, aero-engine works and factories making component parts, including sub-contractors, were asked to work throughout the week-ends of May 25-26 and June 1-2, as well as working full overtime.

Two new Emergency Committees were set up towards the end of May; the first, to deal with airframe production, was composed of Mr. F. S. Spriggs, of the Hawker Siddeley Aircraft Company, Mr. C. R. Fairey, of the Fairey Aviation Company, and Mr. A. Dunbar, of Vickers-Armstrongs; while the second, charged with full authority to deal with the production of aircraft equipment, comprised Mr. C. J. Stewart, formerly Director of Civil Research and Production at the Air Ministry, Sir Allan Gordon Smith, managing director of S. Smith and Sons (Motor Accessories), Limited, and Mr. F. J. E. Brake, managing director of Creed and Company, Limited, and a director of the International Marine Radio Company, Limited. In order to reduce loss of output from air attack, Admiral Sir Edward Evans was appointed to take charge of the local protection and security of the organisation of all factories engaged on aeronautical work and the aerodromes attached to them. Another appointment was that of Mr. A. S. Quartermaine, chief engineer of the Great Western Railway, as Director-General of Aircraft Production Factories, with the responsibility of co-ordinating and superintending the relative priority and progress of work in the erection and equipment of factories for the construction of airframes, aero engines and components.

As a result of these and other measures, Lord Beaverbrook was able to announce, at the beginning of July, that aircraft production during the month of June constituted a record, and was more than twice the output in the corresponding month of the previous year. In addition, the output of engines was more than twice that of June, 1939, thus increasing stocks in this country. This was a matter of some importance, since it seemed at that time as though engines might constitute a serious bottleneck to the expansion of output in the United States.

Very little information is available regarding new types of aircraft, though at the beginning of 1941 some details were released by the Air Ministry about two of the new aircraft, namely, the Tornado fighter and the Stirling bomber. The former is a single-seater fighter designed by the Hawker-Siddeley Company as a successor to the Hurricane. It is powered with a Rolls-Royce Vulture engine, stated to develop 2,000 h.p. The Stirling, produced by Short Brothers, is a four-engined heavy long-range bomber, and is fitted with Hercules engines. Some additional details regarding these aircraft have been given by an American writer in the paper, *Flying and Popular Aviation*. These details, however, have not received any official confirmation. The writer stated that the speed of the Tornado was 425 m.p.h., while the Stirling was said to be faster than existing "Flying Fortresses." He also mentioned two other new aircraft, the Westland Whirlwind, a twin-engined fighter with two Rolls-Royce Merlin engines and a speed of just over 400 m.p.h., and the Avro Manchester, a twin-engined bomber fitted with Vulture engines. The speed of the Manchester was said to be 325 m.p.h., the gross weight 30,000 lb. and the span 90 ft. to 95 ft. Apart from the Vulture, new engines mentioned were the Rolls-Royce Griffin, a 1,600-h.p. water-cooled engine, and the Napier Sabre, a water-cooled and enlarged version of the Dagger.

Second only to the development of production in this country, interest has centred on the supplies received from the United States, and the growth of the aircraft industry throughout the Empire. Several conflicting reports have been published regarding the rate of imports from the United States. It is probable, however, that they were at the rate of 150 to 200 a month in the spring of 1940, and that this had increased to nearly 300 a month by the autumn. Towards the end of the year, British purchasing officials inquired from the United States Treasury whether it would be possible to produce 3,000 planes a month for Great Britain. Investigations showed that this was hardly possible, as it would require the erection of nearly 40 new factories; but agreement was reached on a programme for the production of 1,300 planes a month for this country and, on the strength of this, a new British order was placed for 12,000 machines.

The rate of production in the United States at the end of 1940 was generally estimated at between 900 and 1,000 a month and it was expected that this would increase to 1,500 a month by March, 1941. The Aeronautical Chamber of the United States, however, was recently reported to be contemplating a further outlay of 100 million dols. on aircraft-factory construction, over and above the 52 million dols. already spent for this purpose during the first year of the war. This should result in an additional substantial increase in output in the near future. Expansion of production capacity was considerably facilitated when the United States Excess Profits Bill was modified to allow industry to liquidate the cost of new defence plant on more liberal terms than previously. President Roosevelt has stated that Great Britain was getting 45 per cent. of new construction, and that he had established a rule of thumb policy by which Britain and Canada, on the one hand, and the United States, on the other, would receive defence items, as they came from the factories, in approximately equal proportions. On this basis, Great Britain should now be receiving about 500 planes a month from the United States, and this should increase to at least 750 by March.

In the case of Canada, Mr. Howe, the Minister of Munitions, stated that, during the three months ended September, the number of workers employed on aircraft production had increased by 40 per cent. to about 11,000, and that, during that period, 645 new aeroplanes had become available to the Canadian Government. Extensions of plant costing 3 million dols. were in progress to provide additional aircraft for the Empire training scheme, and plans were being prepared for two other plants at a cost of 2½ million dols. for the construction and overhaul of aircraft. In January it was stated that deliveries of single-engined training planes for the Empire Air Scheme would be completed 15 months ahead of schedule. Out of the total orders placed with two companies for 808 machines, 575 had been delivered by the beginning of December, and, with production rates running at three times the output stipulated in the original contracts, it was expected that deliveries would be completed by the end of January. The two companies would then be able to devote their resources to the manufacture of other types of aircraft. A significant event in July was the arrival in this country of the first Royal Canadian Air Force Squadron, equipped with their own Canadian-built Hurricanes. In August, it was announced that the British Government had placed an order with the Canadian Car and Foundry Company for 600 Hurricanes, to be built at Fort William, Ontario. According to the American press, this company was producing five a week at the end of 1940, shortly to be increased to 25 per week.

In Australia, substantial progress has been made towards the construction of Beaufort bombers, in spite of a succession of unforeseen difficulties. This undertaking was first suggested by the British Air Mission which visited Australia early in 1939. The United Kingdom and Commonwealth Governments agreed to place a joint order for 400 Beauforts to meet the needs of the United Kingdom in Australia and the Far East. Plans, jigs, tools and fabricated parts for the first ten aircraft were to be supplied by the Bristol Company, but this became impossible owing to the outbreak of war. As a result, all jigs and tools had to be made in Australia. In addition, the Taurus engines, which it was intended to use, became unobtainable, and it was necessary to re-design the airframes to take American twin-row Wasp engines and to manufacture these in Australia. In spite of these difficulties, it was announced in August last that the first airframe should be delivered early in 1941, the production of engines would begin during the first half of 1941, and the order should be completed a year later. In October, 1940, it was stated that Australian production of elementary training aircraft was sufficient to cover local requirements and to meet orders from overseas. De Havilland and other elementary trainers were then being produced at the rate of two a day, while the Commonwealth Aircraft Corporation was producing one Wirraway aircraft per day for advanced training.

It has also been decided to start the production of aircraft in India, and in October it was announced that a full-size factory for the manufacture of all types of aircraft was to be started immediately at the Civil and Military Station, Bangalore. Three months previously a new company, the Indian Aircraft Company, Limited, had been formed, with a capital of Rs. 5 crores; and the Government of India agreed to assist the company to obtain the necessary machinery, and to purchase, in the first instance, 50 planes a year. It is reported that American assistance is being sought in providing the required machinery.

## LETTER TO THE EDITOR.

### DISTRICT HEATING.

TO THE EDITOR OF ENGINEERING.

SIR,—I have to thank you for the prominence given to my paper on "District Heating" by making it the subject of the leading article in your issue of January 24. I believe that this is fully justified by the importance of the subject to engineers. To-day engineers are in great demand. After the war, unless we are careful, the trade in bricks and mortar may be thriving while engineers are struggling for bare existence.

It is all the more important, therefore, to emphasise the facts, and I wish to point out one error in your article, which occurs in line 64, on page 72. Here the figure of 4*s.* 3*d.* is given as the weekly charge to the tenants, but this should have been 3*s.* 4*d.*, which is the figure stated in my paper; the figures have unfortunately been transposed. As I emphasised the fact that this charge of only 3*s.* 4*d.* per week is less than slum tenants have to pay for necessary heat and hot water, and that the tenants so favoured have more amenities in this respect than even many well-to-do persons, the error should, I think, be corrected, especially as I stated in my paper that such schemes could be installed and operated at much lower costs.

It affects the whole economic argument and basis of my paper, and I trust you will be able to make this correction, and so emphasise the claim for district heating on economic grounds.

Yours faithfully,
DONALD V. H. SMITH.

180, West Regent-street,
Glasgow, C.2.
January 28, 1941.

[We regret the error.—ED. E.]

MAINTENANCE SCHOLARSHIPS IN ARCHITECTURE.—The Architects' Registration Council of the United Kingdom offers, for award in June, certain maintenance scholarships in architecture. The scholarships will consist of a grant for the payment, in whole or in part, of the school fees and necessary subscriptions, instruments, books, etc., and, when necessary, a maintenance allowance not to exceed, as a rule, 100*l.* a year. The scholarships will be renewable from year to year until the student has completed his or her school training. They will be available for students of British nationality, who could not otherwise afford such training, to enable them to attend architectural schools approved by the Council. The scholarships will be available both for students who have already begun their training and for students wishing to commence it. They would not, generally speaking, be granted to students under 17 years of age. Particulars and forms of application may be obtained from the Secretary of the Board of Architectural Education, Architects' Registration Council of the United Kingdom, 68, Portland-place, London, W.1. Copies of previous year's examination papers may be obtained on payment of 6*d.* The closing date for the receipt of applications, duly completed, is March 19.

# OBITUARY.

## MR. A. J. MAKOWER.

Mr. A. J. Makower, whose death, we regret to record, occurred in London on Saturday, February 1, at the age of sixty-five, did a great deal in the years before the last war to arouse interest in the design and use of the electric-battery vehicle. He was also well known as a painstaking and energetic teacher of electrical engineering.

Alfred Jacques Makower was born in London on May 9, 1876, and began his technical education at University College, London. After a year, however, he went up to Trinity College, Cambridge, where he was successful in the Mathematical Tripos of 1898. He followed this by a two-years course of study in electrical engineering at the Charlottenburg Technical College and, in 1900, joined the staff of the Union Elektrizitäts Gesellschaft, in Berlin, as an engineer in the testing department. Two years later he joined the British Thomson-Houston Company, at Rugby, where he was engaged in designing alternating-current machinery and in the supervision of alternating-current testing under Mr. H. S. Meyer. In 1904, he was appointed head of the Department of Electrical Engineering at the South Western Polytechnic, London, a post he held for the next fourteen years. During the latter part of this time he did a considerable amount of work with his colleague, Dr. W. H. Eccles, F.R.S., on wireless matters, while, with his brother, Dr. Walter Makower, he conducted experiments with kites to investigate the electrical state of the upper atmosphere.

In 1913, he joined Mr. P. A. Mossay in founding the firm of Mossay and Company, Limited. This concern did a considerable amount of pioneer work in the development of electrical vehicles and, in association with Messrs. Ransomes, Sims and Jeffries, Limited, of Ipswich, produced a number of ½-ton and 5-ton electric lorries. Concurrently, a line of platform trucks for goods handling in factories was designed, while they were also responsible for the Runabout and Versatile cranes, which are now manufactured by Messrs. Herbert Morris, Limited, Loughborough. Mr. Makower was also associated with the work of the Reavell-Mossay Pneumatic Tool Company, Limited, of which he acted as secretary. He resigned his position at the South Western Polytechnic in 1918, owing to the claims of business. During the 1914-18 war he was engaged on research for various Government Departments and edited *The Daily Review of the Foreign Press* (Technical Supplement), published by the War Office. Mr. Makower became an associate member of the Institution of Electrical Engineers in 1905 and was transferred to the class of member five years later.

## MR. J. E. WILLCOX.

We regret to record the death, on February 2, at Edgbaston, Birmingham, of Mr. Joseph Edward Willcox, M.Inst.C.E., who was well known for many years as a consultant specialising in municipal sewage-disposal and waterworks design. Mr. Willcox was 84 years of age, having been born in January, 1857. He was educated at Wells grammar school and by private tuition, and received his technical training at the University College, Bristol, which he attended from 1867 to 1874. He was then articled for three years to Messrs. G. C. Ashmead and Sons, engineers, of Bristol, remaining with them for another year as assistant, on the completion of his pupilage, in connection with various sewerage and river training works, and on tramway construction. In 1879, he became assistant to Mr. E. Pritchard, M.Inst.C.E., under whom he acquired additional experience of a similar character at Kidderminster, Solihull, Droitwich, Wallasey and elsewhere, and was also associated with the construction of cable tramways at Birmingham. An appointment followed, in 1881, as resident engineer on the Martley and North Malvern sewerage scheme, and during the next six years Mr. Willcox held similar positions on the sewerage scheme for Erdington and Sutton Coldfield, and a sewage-pumping station at Stratford-on-Avon.

In 1887, Mr. Willcox commenced private practice. He was also appointed surveyor and engineer to the Erdington Urban District Council, and acted in this capacity until 1902, when the development of his general consulting work obliged him to relinquish it. He continued to act as consulting engineer to the Council, however. Among the public services for which Mr. Willcox was consulting engineer were sewage, sewage-disposal or waterworks systems for Stafford, Uttoxeter, Evesham and district, Atherstone, Hanley, Newcastle-under-Lyme, Camberley, Bishop Auckland, Warwick, and Pershore. He was responsible also for the drainage and sewerage arrangements at various county asylums in Staffordshire and Worcestershire, and at a number of hospitals and schools, and was retained in connection with many Local Government Board inquiries and the promotion of local Parliamentary Bills. Mr. Willcox was elected to the Institution of Civil Engineers as associate-member in 1883, and became a member in 1905. He was also a member of the Institution of Municipal and County Engineers, to which he was elected in 1884, and of the Royal Sanitary Institute since 1894. He was made a Fellow of the latter Institute in 1898, and had served on the Council and as a member of the Examining Board.

# A POST-WAR NATIONAL FUEL POLICY.*

By John D. Troup, M.I.Mech.E.

We are approaching a period in the development of human effort which will reveal a new world order, when the nations of the world will consolidate their own industrial and other activities into a world pattern, of which we as a nation will only be a part. The importance of the part we shall play will be dependent upon how we plan for that part; when, it would seem, we shall have to keep in mind two main outlooks, namely, overseas activities, and the development of home activities. The wealth and greatness of this country have been built up on the basis of our native fuel. Other nations have since followed our example. We, however, are still using our native fuel in the same primitive manner that it was used at the beginning of the industrial era, with the exception of the carbonising industry, where again we lead the world, but this industry deals with only a relatively small proportion of our annual coal consumption. We are transmitting fuel energy more effectively by the medium of electricity, but here again we are using our fuel in the same primitive manner, even though combustion is carried out in a highly scientific manner. There are two principal defects in this use of our native fuel, namely, the pollution of the air, and the loss of products which have a higher value than raw fuel. Modern conditions require the application of heat in a manner that will give the highest efficiency for a particular process. We cannot look beyond the limit of modern economics, but it may be within this limit to visualise conditions where the whole of our fuel energy would be provided by smokeless solid fuel, and liquid and gaseous fuels, which would automatically mean the recovery of so-called "by-products" and at the same time eliminate the emission of smoke.

After the last war the Samuel Commission made a most comprehensive inquiry into our fuel problems, and in their recommendation for a National Supervisory Body gave emphasis to the following:—"No comprehensive survey has been made of the heat, light and power requirements of various industries, or of the country as a whole, and how they can be most economically met by the various processes at present commercially feasible: still less has the broad question been considered from the point of view of possible development in the future." The Commission considered that such a survey was imperatively required and that it should be undertaken by a body of a permanent character. Since the Samuel Report was published, the problem has been dealt with by many authorities, and the keynote of all their efforts may be said to be co-ordination. The list includes such names as Sir Arthur Duckham, Lord Hirst, Lord Cadman, Sir Philip Dawson, Professor Egerton, Colonel Bristow, and Mr. Boon. In addition to the above efforts, there have been published certain Government reports, as well as "Labour's Plan for Oil from Coal." It is also significant that the subject is so frequently raised in the House of Commons. During the period in which these efforts have been made, the need for action has been becoming stronger, and to-day there would seem to be an overwhelming case for consideration by a representative body, competent to compile a national plan.

Consider now some of the advantages to be derived from a national policy. Looking at the subject broadly, we can visualise higher efficiencies. With solid smokeless fuel we have a relatively simple product when compared with that complex compound, bituminous coal. Such a smokeless fuel can be used efficiently by relatively unskilled labour, and doubtless apparatus would be developed still further to simplify the process when it became the one class of solid fuel available. Fuels in the liquid and gaseous state are ideal for purposes of control, and their extending use for special processes is evidence of the higher efficiency obtained when fuels of this nature are available.

The ideal we are considering naturally means the processing of raw coal by various methods. It is not proposed to deal with such methods in detail here, but it is evident that our ultimate ideal would mean the building up of a great new industry, possibly in conjunction with the existing carbonising industries. Such a development would be the means of creating new wealth and increasing employment. We are in a much better position to deal with this problem to-day than at any previous time, due to the great advance in our knowledge of the complex nature of coal, and the records of the various seams which have been compiled in recent years by the Fuel Research Station. Unfortunately, we have not made similar progress in compiling statistics on the utilisation side, and it would seem that this is one of the first things to deal with.

The development of a national coal-processing industry would be the beginning of a plan which would ultimately abolish the emission of smoke. There would remain the problem of acid fumes and dust discharged to the atmosphere, but this would come up for consideration when the detailed plan was under review. A great effort has been made in recent years to educate public opinion regarding the harmful effects of atmospheric pollution, and this work will doubtless be a valuable asset in helping forward a national scheme. Some progress has already been made by the extending use of smokeless solid fuel, and also in the use of gas and electricity for heating purposes. There still remains, however, the open domestic grate, which uses a large percentage of our annual production of raw coal.

To-day, when we consider the vast field open to processes using coal as the basic raw material, we see, not one new industry, but a multitude of industries within practical vision, and others ahead if we only have the faith and the courage to provide a much greater organisation for research. It has become a custom to refer to the products derived from raw coal as by-products; but it would seem that the time has arrived to view the matter from a new angle, and consider coal as the raw material for a manufacturing process providing a multitude of products. This section of a national fuel policy is one of the very greatest importance, and one holding potentialities which seem to offer possibilities of development on a grand scale. And here also we have a virgin field for building up home industries which would be of great value in strengthening our financial position as regards balance of trade with other nations. A fair percentage of those who return to civil life will have had a training in our mechanised services, which will be helpful.

In a national scheme there are advantages and conveniences which evolve as the picture becomes more complete. We should have available fuels in a relatively simple form which would tend to standardisation in fuel-consuming equipment. Such equipment would further develop automatic control, and it is possibly within the bounds of practical vision to picture all heating and power plants operating under automatic control, when the personnel would be required only for supervision and maintenance. The use of fuel in the gaseous state would be developed, together with extensions to the grid system which, together with other service supplies, would bring into being a system of underground service tunnels, and abolish the present crude system of the continuous use of pneumatic drills in busy thoroughfares. Another possibility is the pooling of heat energy supply by groups in industrial areas.

In addition to the fuel requirements of industry, business and domestic premises, there is the vast field of transport by land, sea and air. This field calls for very special consideration in any national fuel scheme, principally because the fuel should be in a form for convenience of handling, and provide the maximum heat energy in the minimum of space and weight. To-day, the greater part of the fuel used for transport is in the liquid form. We have witnessed a number of interesting developments during recent years which have been devised to use fuel by other methods. These include compressed gas, producer gas, and liquid fuel derived from raw coal by different systems. It would seem, however, that it is the problem of liquid fuel that calls for immediate attention.

Still another factor in a national fuel scheme is the distribution of the heat energy. Properly designed underground tunnels have been visualised for conveying the different services; but there is another factor which would appear to demand serious consideration—

* Paper delivered before the Institute of Fuel, London, on February 12, 1941. Abridged.

namely, the distribution of heat energy in the form of steam. There is considerable experience available in different parts of the world, from which data may be obtained to guide us on this aspect of the problem. The city of New York has been steam heated through underground mains for more than fifty years; but although there is considerable experience available in America there has been no serious attempt to utilise the steam in a prime mover before delivering it to the street mains. In Europe, however, there is experience on a fairly extensive scale, particularly in Russia, where central power stations have been designed for the purpose of supplying steam heat to wide districts, after the steam has first been used to generate electricity. This aspect of a national fuel policy is primarily one of finding the heating load in order to evolve an economic plan. There would appear to be no serious technical difficulties; and if it were possible to arrange electric power stations in such a manner that condensers were eliminated, and the latent heat of the steam employed for a useful purpose, then the efficiency of the most modern electric power station would have increased by a figure of the order of 100 per cent.

Turning now to the economic side of a national fuel policy, it would seem important to take the longest view possible. The balance sheet must be the test, whether it be a trading concern or the State, but the details of the balance sheet are a flexible quantity. Much money will be required for research, but the results of properly conducted research ultimately show a credit balance. We cannot form an opinion on the economics of a national fuel policy until a definite plan of campaign has been formulated, but there is one aspect which may be suggested here. It may be assumed that any national fuel scheme would visualise the ultimate abolition of smoke. At present, the damage caused by smoke is costing the community annually millions of pounds sterling, not to mention the damage to human health. Is it not possible to capitalise this heavy annual expenditure to assist the balance sheet of any proposed national fuel policy? It may be of interest to record here an extract from the paper read by Dr. J. S. Owens before the Institution of Mechanical Engineers, in 1936, entitled "The Smoke of Cities":—

"An attempt to estimate the cost of smoke was made in 1912 at Pittsburg, and it was then calculated that the cost per head of the inhabitants amounted to 20 dols. per annum. In 1918 another attempt was made in Manchester, in which the Manchester Air Pollution Advisory Board based their estimation on the same methods, and this resulted in a figure of over 1*l.* per head of the population. The average deposit of impurity from the air in these two towns was 360 tons per square mile per annum in Manchester during 1917-18, and 1,031 tons per square mile per annum in Pittsburg during the period of the investigation. The author has suggested as a basis for estimation, accepting the Pittsburg estimate and assuming that the cost varies directly with the amount of deposit from the air, that if this deposit in tons per square mile per annum is denoted by S, then the cost per head of the population would be $S/11 \cdot 9$ shillings. When applied to London, the cost per annum since about 1922 would be approximately 24*s.* per head. The method is somewhat crude, but it gives a figure which is probably approximately accurate."

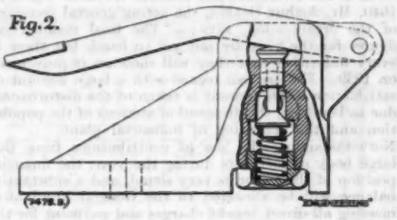
On the economic side there is also the question of coal exports, where we have had to face a dwindling market. If we cannot export wealth in the form of coal we naturally have to turn to other products, and this phase of the problem would seem to be an important factor in considering the economics of a national plan.

We have referred to some of the efforts made during recent years towards this goal. The facts are that they only aroused a certain interest and then went on record. There followed no movement to action. If the time has arrived now for action, what is the best way to set to work? It is clear that no definite movement towards a national goal will take place until the full weight of authority is behind the movement. For such a movement to have full weight, a plan must be devised by the co-operation of the authorities in each branch of activity concerned with fuel problems. With such a plan, backed by authoritative opinion throughout the country, the problem of a national fuel policy would be more than half solved and it should not be an impossible proposition to put it into being. A small committee is generally more effective than a large one. It is proposed that, in the initial stage, a small committee be formed by representatives of each of the institutions more directly concerned with fuel problems. Such a committee would consider the problem from the point of view of forming a skeleton plan. When this stage of the work has been reached, some of the difficulties would be revealed, and also where further advice and assistance would be required. By such stages the committee could be enlarged and strengthened, so building up a representative committee which would embody the authorities of the major activities of technical, industrial and commercial life.

## FOOT-OPERATED AIR CONTROL VALVE.

A VARIETY of machine accessories operated by compressed air, such as chucks and other gripping appliances, require only intermittent operation, and the control may, in many instances, involve the use of one hand of the operator at a moment when both hands might be more usefully employed. This control does not imply any degree of regulation, but simply "on" and "off" movements, which may be easily and correctly performed by the foot. Messrs. B.E.N. Patents, Limited, High Wycombe, have accordingly developed the pedal-operated valve illustrated in Figs. 1 and 2, on this page, and arranged for floor mounting. The external appearance of the valve is

FIG. 1.




shown in Fig. 1, and its construction is illustrated in Fig. 2 in such a manner as to call for little comment. It may be observed, however, that the pedal operates in one direction only, viz., to open the valve, the closing movement, with the consequent return of the pedal, being effected by a strong helical spring below the valve and by the air pressure, since the inlet branch communicates with the chamber in which the spring is situated. The downward travel of the pedal is limited by the depth of its guide notch, its upward stroke being determined by the contact of the valve with its seat. The valve is guided by the spring and a stem which enters the push-button on which the pedal lever rests. The foot-operated valve is made in an alternative form, which, in addition to "on" and "off" control, provides a free exhaust when in the closed position, a condition that is required, for example, when the valve is used for actuating single-acting cylinders which have to be exhausted immediately after a power stroke. This alternative valve gives as instant a response with the minimum of effort, as also does the valve illustrated.

## PROGRESS OF ELECTRICAL RESEARCH.

THE twentieth Annual Report of the British Electrical and Allied Industries Research Association for the year ended September 30, 1940, contains an account of a full year's operation under war conditions. It is satisfactory to be able to record that, though some adjustments have been necessary in procedure and programmes, it has been possible to continue the activities of the Association for the advancement of the electrical industry and at the same time to assist the fighting services and the Government departments directly connected with the war. Briefly, the position is that many manufacturers have found it necessary to direct almost the whole of their activities to developments immediately connected with the requirements of the services, leaving to the Association the maintenance of research in the common interest of the electrical industry.

Similarly, those responsible for maintaining electricity supply have become involved in the many special problems arising out of war conditions and have found it necessary to reduce to a minimum participation in research activities. Here, again, the Association has been able to maintain continuity in dealing with the more urgent problems. Some years ago, the electricity supply industry was the principal benefactory of the work of the Association. It was, therefore, reorganised so that the major financial support came from that section, though considerable assistance was obtained from the manufacturing section and from other interests as well. This has led to the increased development of research activities within the electricity supply industry itself. A recent survey of these developments, however, has disclosed that but little attention is being given to the technology of electricity supply, that is, to the application of the scientific method to the study of problems concerned with the generation and sale of electricity. A good commencement has been made, however, with the study of voltage variation, and other aspects have been touched upon, for example, the economics of electric heating. It has now been decided to go a step farther and a new Sectional Committee to deal with electricity supply technology has been set up to explore the possibilities of work in this field. A second committee will correlate and expand the Association's activities in the important field of heating, cooling and allied problems.

The first portion of the projected extension of the laboratory was completed during the year, and the design of another wing of the new building is receiving attention. This should incorporate an enlarged high-voltage laboratory and afford better facilities for impulse testing. A statement has been prepared detailing the special facilities available, especially the laboratory equipment. A compendium of information on surge phenomena will soon be published, and a commercial form of the Association's type of surge filter for protecting equipment against damage from lightning is to be introduced.

Preliminary tests with a view to comparing direct-current with alternating-current stress distribution have been made on simple models of composite insulators. This has involved the development of apparatus of a novel type to enable the value of equipotential surfaces to be determined under controlled conditions of temperature and humidity at short intervals of time after the application of the voltage. The tests have not been completed, but it would appear from the results so far obtained that the stress distributions are not substantially different under normal conditions for the dielectrics tested, provided that only times of the order of one second are considered. Further efforts are being made to trace the source and magnitude of the voltage that causes surface sparking on structures when switchgear is operated.

A programme of research on insulated cables run in steel pipes has been completed. The results apply not only to installations in buildings, but also to short runs on external walls, under roadways and in similar conditions. The investigation covered the current rating and impedance of the cables themselves when carrying either direct current or single- or three-phase alternating current, and the heating effects on the steel pipes. This afforded a check on the theory of alternating-current losses in steelwork which has already been developed by the Association. The investigation on the effects of short circuits on the power factor and discharge voltage of cables, with a view to detecting damage through mechanical and thermal effects, has been continued on the basis of the preliminary measurements referred to in last year's report. Examination of styrene wafers cut from cables under test suggests that deterioration is probably due to thermal rather than electromagnetic effects. Interesting data have been obtained on the nature of the mechanical distortion and the pressure rise in the end boxes. An extensive experimental investigation on the current rating of cables as installed on board ship is now well in hand. It is expected that an interim report concerning vulcanised rubber lead-covered cables of sizes from 0·01 sq. in. to 0·4 sq. in., and in groups up to 18, installed in metal trays below a steel deck will be completed shortly.

During the year the total-heat determinations at high steam temperatures and pressures have been completed, and investigations have been made on the total heat of steam below atmospheric pressure. Active progress has been made on the creep and impact properties, composition, heat treatment and microstructure of complex molybdenum steels at various temperatures and stresses and in different media. Investigations have been made on molybdenum and vanadium steels to estimate the stresses to produce 1 per cent. creep in 100,000 hours at various temperatures and to determine whether fracture was likely to occur with less than 1 per cent. elongation. Prolonged creep tests due to fracture, further study of the impact and creep properties, and microstructure of molybdenum-vanadium steels after various heat treatments have been made and new steels containing varying percentages of these elements have been prepared and are being investigated.

## LABOUR NOTES.

THE Ministry of Labour and National Service states that at January 13 there were on the registers 521,388 persons who were wholly unemployed, 152,381 who were temporarily stopped, and 21,837 who are normally casual workers. The corresponding figures at December 9, 1940, were 541,900, 141,848 and 21,531. Of the wholly unemployed at January 13, 236,957 were men 22,005 boys, 222,142 women, and 40,284 girls. Of the temporarily stopped, 89,699 were men, 2,360 boys, 56,936 women, and 3,386 girls, and of the casual workers, 20,606 were men, 68 boys, 1,149 women, and 14 girls. Between December 9, 1940, and January 13, 1941, the numbers of unemployed on the registers decreased by 4,288 in the London area, 644 in the Southern area, 2,672 in the South-Western area, 8,231 in the Midlands, 2,821 in the North Midlands, 1,802 in the Northern area, and 8,928 in Wales. They increased by 3,038 in the Eastern area, 5,414 in the North-Eastern area, 1,373 in the North-Western area, and 9,388 in Scotland.

Employment Exchange Panels have reached another stage in the examination of workers who have been unemployed for long periods. Since August last, 185,000 men have been seen, and of that number, 47,000 were classified as unsuitable for normal industrial employment—not necessarily unfit for light or specially easy work—and it has been ascertained that only 31,000 of the 47,000 were on the register in January. Nearly all of the 16,000 had obtained some employment. An amended figure of women, evacuated and registered in the areas to which they have moved, shows the total to be 23,000.

The Minister of Labour and National Service has decided on a re-organisation of his principal assistants as part of his plans for carrying out the new man-power programme. Mr. F. W. Leggett, the Chief Industrial Commissioner, is to take charge of the department dealing with welfare and the administration of the Factory Acts as well as the Industrial Relations Department. He will be assisted by two Industrial Commissioners—Mr. R. Lloyd Roberts, whose services have been made available by Imperial Chemical Industries, and Mr. J. G. Little, formerly president of the Amalgamated Engineering Union and more recently a director of labour supply at the Ministry of Labour. The object of the re-arrangement is understood to be to place, under one direction, the related problems affecting wages and working conditions, and of welfare inside and outside the factories, which may arise through the transfer of large numbers of men and women in connection with the Minister's new proposals.

Addressing the annual conference of the National Federation of Professional Workers, Mr. G. W. Thomson, the president, said that a good deal of recent legislation had had the effect of restricting professional workers in many ways, rendering movements for improvements impossible and diluting the profession by ill-digested training schemes. To save the country from catastrophe, extensive powers of compulsion had been, and would be, granted to the national executive, but non-manual workers had the right to ask that such compulsion should be applied equally. Because employers had not taken the precautions enjoined on them, disastrous fires as the result of air raids had occurred in our great cities, and non-manual workers were to be compelled to watch their employers' premises without pay in preference to their own homes.

The Post Office requires hundreds of women for duties of a minor engineering character in telephone exchanges throughout the country. Candidates will be trained by the Post Office. Some will repair the cords used to connect callers and which fray from constant use, some will be employed wiring up the distribution frames where the cables containing circuits are split up, and some will assist engineers, testing the quality of telephone circuits and keeping records of any faults that may occur. In London, the pay will be 44*s.* a week at 21 years of age, 46*s.* at 22, and 48*s.* at 23 and over. The corresponding wages in the provinces will be 40*s.*, 42*s.*, and 45*s.*

At a conference last week, the Railway Executive Committee replied to the claim of the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Clerks' Association for a flat rate wages increase of 10*s.* a week. The meeting was adjourned to enable the executives of the unions to consider the reply. Only the traffic and clerical grades are affected by these negotiations; other procedure is prescribed for the shopmen.

As is known, the Leicester hosiery industry has been selected for the first large-scale movement of women from one industry to armaments work. One thousand women are to be transferred and a quota system is to operate in order to ensure that each factory contributes its share. Volunteers, after registering with their employers, are to remain at work until called up. According to Mr. S. F. Peshall, the chairman of the advisory committee of employers and trade-union representatives which is dealing with the matter, it is believed that a successful voluntary system is possible. In a single factory where, he says, an appeal was made for 30 volunteers to be trained for munitions, 60 came forward from one department alone.

In last week's ENGINEERING, an account was given of a meeting between the Production Executive of the Cabinet, the British Employers' Confederation and the General Council of the Trades Union Congress. It was explained that Mr. Bevin, the Minister of Labour and National Service had outlined the Government's plans for large reinforcements of the fighting services, the better distribution of man-power for the prosecution of the industrial war effort, and a large increase in the number of women in works and factories. Informal meetings subsequently took place between representatives of the General Council and the Minister. Having had the outcome of these discussions under consideration, the General Council at a meeting last week, "noted with satisfaction that the Government proposes to use the voluntary method to the utmost possible extent and decided to request all affiliated unions immediately to co-operate with the respective employers' associations in jointly surveying their industries with a view to securing the utmost results from voluntary co-operation."

Reviewing in the February issue of the *Record*, the work of the Transport and General Workers' Union in 1940, Mr. Arthur Deakin, the acting general secretary of the organisation, says:—"The final membership figures for the year are not yet to hand, but there is every indication that they will show an improvement on 1939. This we can regard with a large amount of satisfaction when account is taken of the disturbances due to bombing, the dispersal of sections of the population and the spreading of industrial plant. . . . Notwithstanding the loss of contributions from this large body of members during the year, the financial position of the Union is very sound, and a substantial balance will be allocated to the General Fund after meeting all direct benefit charges and payment for the manifold services which the Union provides."

It was mentioned in these Notes a week ago that the International Labour Organisation is now largely operating from Montreal. In the November issue of the *International Labour Review*, Mr. John G. Winant, the Director—who is now, of course, the United States Ambassador to Great Britain—writes that as "the work of the Organisation has retained its full importance, it is essential that the activities of the Office be carried on in a place where communications are assured and where the staff can direct its entire energies to the problems which lie ahead." "Without social justice," Mr. Winant goes on to say, "there is no lasting peace; the I.L.O. is continuing with this conviction in mind. The work of the Organisation has always been based upon the belief that accurate knowledge and informed discussion are essential preliminaries to the formulation of wise social policies. The Organisation is the only official international agency through which Governments, organised labour and organised employers work in this way for the realisation of social justice."

The primary objectives of the Organisation are, Mr. Winant says:—"(1) To attain a higher standard of living for the entire working population, with increased production and enlarged and adequately distributed purchasing power. (2) To assure employment and to realise a greater degree of social security for the men and women of all countries. (3) To perfect a concept of economic and social democracy as a necessary supplement to political democracy." "To-day," he continues, "the defence of every country rests ultimately upon the strength of its social structure. It is the duty of the I.L.O. to help to formulate a practical social programme that will assure to the people recognition of their needs and to each member country sound social and economic institutions. The Office will attempt to assemble as complete documentation as possible for the peoples who will rebuild the social order. The publications of the Office are being resumed; the research programme is again under way; plans for conferences, committees, and more general meetings are being scheduled; and experts from the Office are rendering services to member Governments. Countries which are at war and countries which are at peace are drawn together in the I.L.O. in the accomplishment of its tasks. We look to the future with determination and undiminished faith."

## MARINE ENGINEERING AND THE CLASSIFICATION OF SHIPS.*

By DR. S. F. DOREY, M.I.Mech.E.

CLASSIFICATION may be defined as "a division by groups in order of merit." In its more limited application to ships, the word was originally intended to signify a grading in order of strength and seaworthiness, each grade being assigned a symbol or character by which merchants and underwriters could compare the relative merits of one vessel with another. Later, however, the increasing uniformity of practice in shipbuilding and marine engineering, effected mainly by the application of ever more comprehensive Rules, led gradually to the elimination of the inferior characters assignable to vessels, until to-day classification implies compliance with a single standard of quality, and thereby acquires the nature of a hall-mark.

The Phœnicians, Greeks and Romans all practised marine insurance. There is a direct reference to the subject in the Justinian Code of the early Sixth Century, in which the premium to be charged for "the perilous adventure of nautical insurance" was fixed at 12 per cent. The practice was further developed by the Italian republics of the Middle Ages and later by the Hanseatic League, which introduced marine insurance into England through its London colony, the Merchants of the Steelyard. The early underwriters and merchants must have possessed some knowledge of the vessels in which they were interested. It is unlikely they would be willing to insure or employ ships without first satisfying themselves in some way as to their quality, and it is highly probable that they made it their business to collect information about these ships. With the expansion of commerce the number of ships multiplied, and the task of keeping a record of their condition and efficiency grew beyond the means of any one man. It is therefore more than likely that traders and underwriters made a practice of pooling their information. It was not until the end of the Seventeenth Century, however, that the business of marine insurance and shipping intelligence was placed on a regular and organised basis. At that time an innkeeper named Edward Lloyd, of Tower-street, London, commenced to collect and circulate among his patrons regular shipping news. This proved so successful that, in 1696, he published *Lloyd's News*, from which, 30 years later, sprang the world-famous *Lloyd's List*. It is also probable that the early patrons of Lloyd's Coffee House kept for their own guidance documents termed "ships' lists," written by hand and containing particulars of vessels which underwriters were likely to have offered to them for insurance. These lists were the forerunners of the subsequent Registers of Shipping, and in principle differed little from those in use to-day. The earliest printed Register in existence is dated 1764-5-6. Any alterations were originally made in pen and ink, but, by 1775-76, at which time the familiar class A1 appeared, they were set up in type and posted weekly by hand, a practice which is peculiar to Lloyd's Register Book and which has been continued uninterruptedly down to the present day.

The early Register was known as the Underwriters' Green Book, but probably enjoyed some support from shipowners. In 1797, however, the basis of classification was altered in such a way as to make the character of a vessel entirely dependent on her age and place of build, irrespective of her intrinsic merit at the time of survey. Under this system, also, Thames-built vessels were favoured at the expense of vessels built at other ports, with the result that shipbuilding enterprise outside the Thames was placed at a considerable disadvantage. Shipowners were dissatisfied at such an irrational system of classification and published a rival Register Book in 1799, which became commonly known as the Shipowners' Register, or Red Book. This quickly gained in popularity and public support, until in 1801, the Red Book contained particulars of even more vessels than that of its older rival. Age and place of build were used as a basis of classification also by the Committee of the Red Book, albeit to a less extent than in the Green Book. Further, under the rules of both societies, no amount of repairs could reinstate a vessel which through age had lapsed from the first, or A1, class; nor were there any rules for the construction and systematic survey of vessels, while the surveyors were practically uncontrolled in their decisions. This lack of sound principles provoked in increasing degree the hostility of a large section of the shipping community, until in 1823 a series of protest meetings was held for the purpose of urging radical changes in the constitution and principles of the Registers. It was not until ten years later, however, that matters were brought to a head and a meeting

* The 13th Thomas Lowe Gray Lecture, entitled "Progress in Marine Engineering as Influenced by the Classification of Ships." Delivered at the Institution of Mechanical Engineers, London, S.W.1, on Friday, January 24, 1941. Abridged.

was arranged between representatives of the two Registers with a view to conciliation. In consequence, it was unanimously decided that the two societies should be amalgamated under the name of Lloyd's Register of British and Foreign Shipping. In 1834, the new Register commenced its operations, its constitution and general policy being a great improvement on those of the parent societies.

Under the new constitution, merchants, shipowners and underwriters were to have equal representation on the committee, who were to have full powers to frame their own by-laws, not being inconsistent with the original rules and regulations under which the Society was established. The characters assigned were to be an indication of the real and intrinsic quality of vessels and were not, as previously, to depend on the place of build; further, such assignments of character were to be made, not by the surveyors, but by the committee itself after due consideration of the surveyors' reports. The original constitution of 1834 has remained fundamentally unaltered down to the present day, any changes since introduced having been mainly in the direction of securing the widest possible representation of shipping, shipbuilding, engineering, and steel interests on the committee and in extending the Society's activities to other countries.

The first practical application of steam power for marine purposes was the construction of the paddle steamer Charlotte Dundas, in 1803, by Symington. She proved the inspiration which, in 1807, led Robert Fulton of America successfully to complete the world's first passenger steamship, the Clermont. On this side of the Atlantic, Henry Bell built the famous Comet, which was put into service between ports on the Firth of Clyde in the year 1811. Bell's example was quickly followed by builders at other ports, including London. It seems, however, that the interest aroused in the new propelling medium tended to tempt the early engineers to run before they could walk, and boiler explosions were frequent. In fact, in 1817, a Parliamentary Committee was convened to consider "the means of preventing the mischief arising from explosions on board steamboats." As a result regulations were issued which called for the compulsory registration of all steamships and stipulated that the boilers of passenger vessels were to be of wrought iron or copper and were to be subject to inspection. Additionally, each boiler was to be equipped with two safety valves and was to be tested to three times the working pressure, which was to correspond by calculation to a factor of safety of not less than six. The first record of a steamship to be found in the Register Books is that of the steam packet James Watt, of 294 tons, classed A1 in the 1822 issue of the Green Book. From this time onwards the number of classed steam vessels rapidly increased, the Green Book for 1827 containing 81 steamers, while that for 1832 included 100.

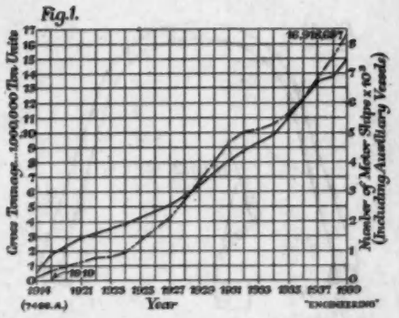
At the commencement of the Society's history in its reconstituted form, the regulations in respect of steamers were very brief and did not call for the survey of the machinery by the Society's surveyors. The rules were based on the Government Regulations then in force and merely required that the machinery should be surveyed twice yearly by a competent master engineer, who was to sign a certificate describing the condition of the engines and boilers. The classification of hull and machinery was not at that time made interdependent, as is the case to-day.

In 1834, a typical installation in a steamer consisted of paddle wheels driven by side-lever engines with a boiler supplying steam at a pressure of about 3½ lb. per square inch. The successful introduction of the screw propeller about 1837 gave an added impetus to steam propulsion and paved the way for various new types of engines, including the direct vertical marine engine. The boilers in use at that time were of the box type, which was weak in design, and this, in conjunction with poor workmanship and methods of manufacture, precluded the use of pressures above 25 lb. per square inch. The heavy loss of life resulting from boiler explosions led the committee to take steps to enforce more rigid compliance with the rules relating to the survey of machinery. Although it was not yet decided to appoint special engineer surveyors, a step in the right direction was made in the year 1869, when, for the first time, the engines and boilers were included as part of the vessel's equipment, and the assignment of the figure "1" of the vessel's character was made conditional upon their safety and efficiency. The compound principle was introduced by John Elder in 1854, and by 1860 was in general use, with screw propellers, in the form of the inverted vertical, or "steam hammer" type, at which time also surface condensation was becoming increasingly favoured. The success attending the compound engine led, in 1871, to the development of the triple-expansion type, and thereby to the use of higher boiler pressures up to 60 lb. per square inch. This, in turn, necessitated improvements in boiler design, the result of which was the appearance of the Scotch, or cylindrical, type.

By 1873, the greatly increased number of steam vessels impelled the committee seriously to consider the question of the survey of machinery. As a result, in the following year the first fully-qualified engineer-surveyor was appointed and other appointments quickly followed. One of the first reforms recommended by the engineer-surveyors was the prevention of accidental flooding resulting from faulty bilge-pumping arrangements. There can be little doubt that many mysterious founderings prior to these improvements must be attributed to this cause.

A valuable result derived from the appointment of an engineering staff was that, from their reports on the scantlings of the machinery and boilers of vessels, the committee were soon in possession of information as to the practice of the principal marine engineers in the country, and were, therefore, early in a position to formulate rules for the strength and construction of boilers. The first rules aimed chiefly at a standard of strength and safety in the more important respects but placed no restrictions upon the design and proportions of engines. The committee shortly after introduced the principle that the machinery of all new steam vessels to be classed with the Society should be constructed under the supervision of the engineer surveyors. Thus were the classification of hull and machinery made interdependent. The logical extension of this important step was the requirement issued in 1879 to the effect that periodical surveys of the machinery of vessels were also to be carried out by the engineer surveyors concurrently with those held on the hull and equipment. Additionally, the boilers were to be subjected to annual survey after they were six years old. A study of marine engines and boilers in use at the commencement of the period under review brings convincing evidence to show that the modern successors

*Fig. 1.*




to the earlier types owe much of their superiority not only to improved methods of manufacture and advances in the quality of materials, but also to the close observance of their behaviour under service conditions, which a regular and reliable periodical survey entails.

The introduction of steel made by the Siemens-Martin open-hearth process, about 1877, led to rapid developments in marine engineering in the next twenty years. By 1890, the triple-expansion engine was in general use, while in that year the quadruple-expansion engine was first applied to the propulsion of large vessels. About this time, also, the water-tube boiler was being developed, although mainly for naval purposes. Following the satisfactory experience with steel in ships and boilers, greater attention was next given to forgings and castings. Prior to 1888, only large iron forgings were examined at the forge, others being inspected after delivery. At this date a system of inspection of all large forgings and castings during and after the process of manufacture was instituted, together with regulations for their quality, a change of system which proved of considerable benefit both to makers and purchasers. The regulations for the testing and inspection of steel material were revised. These regulations provided for a thorough supervision by the Society over the manufacture and testing procedure adopted at all steelworks producing steel for use in classed vessels or machinery. At the same time, the Society published its first rules for the sizes of shafting. These were amended in 1900 in view of the increasing number of screw-shaft failures, particularly in vessels engaged on Atlantic voyages in ballast.

The year 1897 must be regarded as a milestone in the history of marine engineering, in that it witnessed the triumph of Parsons with his world-renowned Turbinia at the Spithead Naval Review, and from that time onward the Society was closely associated with the application of steam turbines to ship propulsion. In 1903, the Cunard Steam Ship Company approached the committee with a request that the Society's chief engineer surveyor, Mr. James T. Milton, might serve on a special committee to inquire into the practicability of adopting turbine machinery for the new fast Atlantic steamers to be built under agreement with the Government. As a result of the findings of the Inquiry Committee, steam turbines were installed in the Mauretania and Lusitania. The beginning of the present century marked the extensive development of the use of the steam turbine in merchant ships. In 1905, there were ten classed turbine vessels, of a total tonnage of 16,000 gross tons, in the Society's Register Book, and by 1908 this had increased to 30 ships, of a total tonnage of 166,000. Low-pressure steam turbines in conjunction with reciprocating engines were also being introduced at this time. In 1906 the subject of gas engines for marine propulsion was first brought under the notice of the committee, and in 1910 the classed vessel Holzapfel I, of 260 tons, was constructed and fitted with a suction gas engine, using anthracite as fuel and developing 180 h.p. at 450 r.p.m. The engine which was not reversible, was connected to the screw shaft through a Föttinger transformer.

Meanwhile increasing attention was being devoted to petrol and oil engines. By 1908, more than 2,000 British and American yachts had been fitted with internal-combustion engines, and the possibilities of the use of these engines for the motive power of ocean-going vessels became evident. In the investigation and solution of the various problems which confronted the early designers and engine builders the Society was actively associated, and, in particular, Mr. Milton, the chief engineer surveyor, made a special study of the subject. Valuable papers were read by him before the Institution of Civil Engineers* and the Institution of Naval Architects.† Visits were also paid by Mr. Milton to makers in this country and on the Continent with a view to an interchange of opinion on the various problems then receiving attention. The pooling of the available accumulated experience of so many engine builders enabled the committee early to formulate rules for the shafting and for the construction of these engines.

The year 1912 witnessed the construction of the famous motorship Selandia and her sister vessel Fionia by Messrs. Burmeister and Wain for the East Asiatic Company. Prominent British, Dutch and Swedish owners soon followed the courageous lead given by the Danes. Conversions from steam to oil engines were also successfully accomplished and by 1914, when the Society issued its first rules for the construction and survey of Diesel engines and their auxiliaries, there were 27 classed vessels so fitted and 20 others building to class, in addition to 36 classed motorships fitted with heavy-oil engines of other than Diesel type. These rules were perforce of a somewhat tentative nature, in view of the limited experience available. By this time, also, two-stroke single-acting engines

TABLE I.—USE OF STEAM AND INTERNAL-COMBUSTION ENGINES.

| Register Book. | Total Steamer and Motor Tonnage (including Auxiliaries), Tons Gross. | Type of Engines. | | | Fuel. | | | |
|---|---|---|---|---|---|---|---|---|
| | | Steam Reciprocating, Tons Gross.* | Steam Turbines (including Turbo-Electric), Tons Gross. | Internal-Combustion Engines (including Diesel-Electric), Tons Gross. | Coal. | | Oil. | |
| | | | | | Tons Gross. | Per Cent. | Tons Gross. | Per Cent. |
| 1922-3 .. | 61,342,952 | 51,653,324 | 8,149,165 | 1,540,463 | 45,338,327 | 73·9 | 16,004,625 | 26·1 |
| 1925-6 .. | 62,380,376 | 50,566,029 | 9,100,274 | 2,714,073 | 41,862,181 | 67·1 | 20,518,195 | 32·9 |
| 1928-9 .. | 65,159,413 | 50,045,048 | 9,682,063 | 5,432,302 | 40,674,097 | 62·4 | 24,485,316 | 37·6 |
| 1931-2 .. | 68,722,801 | 50,225,758 | 9,065,610 | 9,431,433 | 39,289,061 | 57·2 | 29,433,740 | 42·8 |
| 1934-5 .. | 64,357,792 | 44,728,790 | 9,024,476 | 10,604,526 | 33,895,555 | 52·7 | 30,462,237 | 47·3 |
| 1937-8 .. | 65,271,440 | 42,221,346 | 9,301,381 | 13,748,713 | 31,746,906 | 48·6 | 33,524,534 | 51·4 |
| 1939-40 .. | 68,508,432 | 41,863,163 | 9,727,582 | 16,918,687 | 31,015,069 | 45·3 | 37,494,363 | 54·7 |

* Vessels fitted with a combination of reciprocating and turbine machinery are now included under the heading of "Steam Reciprocating"; prior to 1929, they were included under "Steam Turbines."

* *Proc. Inst. C.E.*, vol. 168 (1906-7), "Internal Combustion Engines for Marine Purposes."

† *Trans. Inst. N.A.*, vol. 53 (1911), "Diesel Engines for Sea-Going Vessels."

were being employed for ship propulsion, notably by Messrs. Sulzer Brothers, of Winterthur. In 1914, Messrs. Doxford, of Sunderland, introduced a two-stroke opposed-piston engine which was subjected to an interesting shop trial of 34½ days duration. In the course of the trial the Society's surveyors continuously checked the data obtained and the results proved in every way satisfactory.

About 1921, there was a marked increase in the horse-power per shaft of oil engines, and in the light of the experience gained since 1914 amendments were made to the Society's existing rules for the sizes of straight shafting for Diesel engines. The early rules were based substantially on torque-fluctuation coefficients comparable with those found in steam reciprocating practice, but experience indicated that this was rather severe, in view of the much greater flywheel effect due to larger reciprocating and revolving masses in the engine itself. Accordingly, the rules were adjusted to allow for the greater torque-smoothing effect in the oil engine as compared with the steam reciprocator. At the same time, special rules were adapted for oil engines of other than Diesel type, with maximum cylinder pressures varying from 200 lb. to 550 lb. per square inch.

The year 1925 saw the successful revival of the double-acting principle in the construction of the Gripsholm for the Swedish-America Line. Other and still larger vessels have since been fitted with double-acting machinery, notable among which are the Augustus, of 32,650 tons, the Britannic, of 26,943 tons, and the Georgic, of 27,759 tons. In 1930, as a result of the rapid advances in this type of engine and in the light of extended experience generally, the Society's rules were revised and brought up to date with the inclusion of rules for double-acting engines. As a basis for the rules governing the sizes of crankshafts, the maximum and mean indicated cylinder pressures, in conjunction with bore, stroke, and span between main bearings, were adopted, and having regard to the complexity of the problem it may fairly be claimed that the rules in their present form have given general satisfaction under all normal conditions of working. Fig. 1, page 139, shows the number and tonnage of all motorships appearing in Lloyd's Register Book since 1914, and indicates the remarkable growth in the application of oil engines for marine propulsion.

Continued progress also took place in other fields of marine engineering. Geared turbines, introduced to the Merchant Service about 1914, had increased to a remarkable extent by the end of 1918, and additional attention was being given to turbo-electric propulsion. In 1928, proposals for fitting pulverised-coal burning equipment were specially considered and a number of these plants were installed in classed vessels. Unfortunately, the success hoped for did not materialise, and most of the installations were removed after a short period of service. Mention should also be made of the great extension in the use of superheaters with cylindrical boilers, and the increase in the use of mechanical stokers.

There has also been a resurrection of the earlier proposals of Sir Charles Parsons, in 1911, to deal efficiently with low-pressure steam by employing a low-pressure turbine in conjunction with reciprocating engines. The modern system employs the exhaust steam from the reciprocator to drive a turbine which is employed in one of the following four ways: (*a*) connected to main shafting by reduction gearing and hydraulic clutch—the Bauer-Wach system; (*b*) to drive a directly-coupled electric generator which supplies power to a motor mounted on the shaft, as in the system developed by the Metropolitan-Vickers Electrical Company; (*c*) by driving a steam compressor drawing steam from the high-pressure cylinder exhaust and delivering it to the intermediate-pressure cylinder—the "Götaverken" system; and (*d*) to drive an electric generator which supplies current to an electric heater through which the steam passes from the high-pressure to the intermediate-pressure cylinder—the "Lindholmen" system.

The extent of the developments which have taken place during recent years in the use of steam turbines and internal-combustion engines is shown in Table I, page 139, which gives the relative proportions of (1) steam reciprocating engines; (2) steam turbines; and (3) internal-combustion engines. It is also an index to motive power, and shows for the same periods and vessels the proportion of tonnage propelled (*a*) by the use of coal, and (*b*) by the use of oil, either as fuel for boilers or motors. This category includes a number of vessels which burn either coal or oil in the furnaces of their boilers. The table embraces all existing vessels of 100 tons and upwards, as recorded in Lloyd's Register Book, and shows the continued increase in motor tonnage and in the use of oil as fuel. The shaft-horse-power of turbine machinery driving passenger liners has now reached the huge total of 200,000 in a single vessel, while in the case of motorships, the greatest power has recently attained 38,000 brake horse-power.

*(To be continued.)*

## "ENGINEERING" ILLUSTRATED PATENT RECORD.

### ABSTRACTS OF SPECIFICATIONS RECENTLY PUBLISHED UNDER THE ACTS OF 1907 TO 1939.

*The number of views given in the Specification drawings is stated in each case; where none is mentioned, the Specification is not illustrated.*

*Where inventions are communicated from abroad, the Names, etc., of the Communicators are given in italics.*

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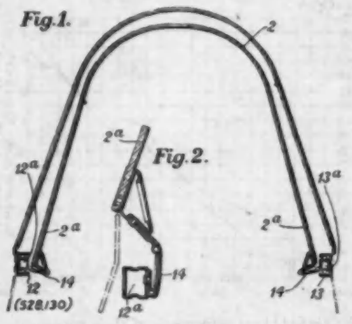
### AERONAUTICS.

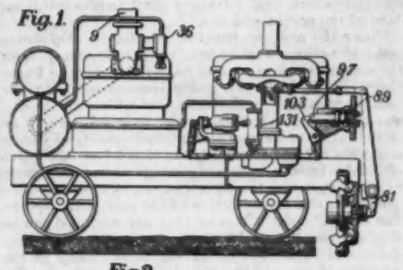
**528,130. Aircraft Cabin Top. Reid and Sigrist, Limited, of New Malden, and C. Bower, of New Malden.** (4 *Figs.*) April 27, 1939.—The invention is a sliding door for an aircraft cabin top. The cabin top has three main sections, a wind screen, a sliding door 2, and a fixed rear cover. The whole cabin top is built up of transparent panelling on light metal framework of the type usually employed in aircraft construction. The sliding door 2, when closed, lies flush with the cabin top as a whole, its forward and rear edges forming a continuous abutment with the rear and forward edges of the wind-screen and the fixed cover respectively. The door, being of inverted U-section, with somewhat downwardly divergent walls, is resiliently constructed so that it can be "nipped" or contracted in breadth. The door runs on guide rails 12, 13, which extend rearwards within

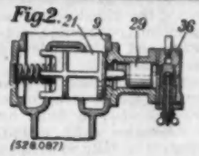



the fixed cover for the full length of the door. In order that it may be slid back within the fixed cover there are hinged collapsible extensions 14 to the side walls 2a to form a double "piano hinge" extending the whole length of the door. The door is supported at each side, through these "hinge" extensions, on runners 12a, 13a, which run in the channel 12, 13 on caged balls. When the hinges are collapsed, there is a simultaneous dropping of the door, and a diminution of the spread of the walls 2a relative to the walls of the fixed cover. The door can now be slid into the rear fixed cover. The extensions 14 constitute draught excluders, and by passing over the dead centre when collapsed, they render it unnecessary to provide locks for retaining the walls 2a in their contracted position. Contraction of the door is effected by a Bowden wire control mounted in the cabin. (*Accepted October* 23, 1940.)

### PUMPS.

**528,087. Air-Compressor Regulator. E. W. Moss, of London** (*Ingersoll-Rand Company, of Jersey City, U.S.A.*) (3 *Figs.*) April 27, 1939.—The invention is a regulator for motor-driven air compressors which enables the motor to run at minimum speed unless the load becomes heavy enough to drain the compressed-air receiver faster than the compressor can reload it at minimum speed. The air intake 9 contains an unloading and reloading reciprocating valve 21 (Fig. 2). The valve is spring loaded towards the open position and is moved to the closed position by a piston 29. An auxiliary valve 36, controls the admission of air under pressure to the piston chamber. The area of the auxiliary valve when closed is less than its area when open, so that, once opened, the receiver pressure can fall by a certain amount before the valve re-closes. The speed of the motor is controlled by a centrifugal governor (shown enlarged in Fig. 1), which operates the throttle through a lever 81. The control spring 89 of the governor is housed in a casing secured to the frame of the motor, and one end abuts on a plunger 97 while the other end presses against a projection on the lever 81. The plunger 97 bears against a hook lever 103, the position of which is varied, to vary the speed setting of the governor in accordance with the receiver pressure, by means of a piston which is itself controlled by a second auxiliary valve 131 identical in all respects with the auxiliary valve 36. When the compressor is working, the valve 131 remains closed during the initial period of loading of the receiver. When, however, the pressure in the receiver rises sufficiently to open the auxiliary valve 131, its associated

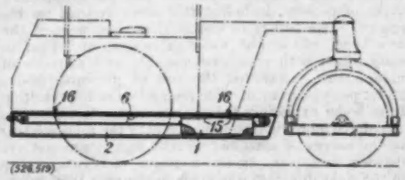



piston moves so as to retract the hooked lever 103 and permit the governor spring to expand. This allows the governor to close the throttle, and the motor then operates at its minimum speed. In general, the operation of the unit is as follows: When the machine is started, both the auxiliary valves 36 and 131 are closed, leaving the unloader valve 21 in its open position and the speed governor at its maximum speed setting. When the pressure builds up to, say, 100 lb. per square inch, the valve 131 opens and changes the governor setting to minimum speed. If the load is constant, the compressor then supplies the air required at minimum speed. If the pressure continues to build up in the receiver to the maximum allowable pressure, say, 105 lb. per square inch, the valve 36 closes the unloading valve 21 and thereby prevents further loading of the receiver. If the load now increases, the pressure in the receiver falls and when it reaches, say, 85 lb. per square inch, the valve 36 closes and the unloading valve 21 opens again, permitting the reloading of the receiver. So long as the load does not increase to the point where the pressure in the receiver falls to a minimum of, say, 80 lb. per square inch, the valve 131 remains open and the machine continues to operate at minimum speed. Should the load increase, however, and the pressure fall to this minimum, the valve 131 closes, permitting the motor to accelerate to its maximum speed. (*Accepted October* 22, 1940.)

### MISCELLANEOUS.

**526,519. Road Roller. Aveling-Barford, Limited, of Grantham, and W. H. Bramble, of Grantham.** (4 *Figs.*) March 18, 1939. The road roller is of the class which has a front roller for steering and rear driving rollers arranged on each side of the front roller. For satisfactory rolling the pressure per unit of width exerted on the ground by both the front and rear rollers respectively, should be as nearly equal as possible. In negotiating hills, however, it is necessary to construct the machine so that about two-thirds of its total weight is carried by the driving rollers; hence the uniform distribution of compressive power has not hitherto been compatible with the best hill-climbing ability. The road roller illustrated is




provided with a movable ballast weight 1 so that the distribution of weight can be varied as required. The ballast weight is adjustable from a position within the wheel base to one behind the rear axle. The channel section chassis members 2 provide suitable guides for the weight, which runs on rollers on the inturned flanges of the chassis members. A wire rope 6 is anchored to the weight and winds on a drum rotated by a detachable crank handle. A clamping screw on the drum spindle bearing locks the spindle so as to keep the weight in position. To prevent the weight from rattling, it is formed at both sides with inclined faces 15 and adjustable screws 16 in the flanges of the chassis members can be adjusted to bear on them so that the weight is wedged tightly in the frame. (*Accepted September* 19, 1940.)